The Dissertation Committee for Yujung Ko Certifies that this is the approved version of the following dissertation:

Information-Seeking Behaviors of Teachers for Technology Integration:

A Case Study of Two School Districts

Committee:

Joan E. Hughes, Supervisor

Xiaofen D. Keating

Min Liu

Diane L. Schallert

Melissa M. Wetzel

Information-Seeking Behaviors of Teachers for Technology Integration: A Case Study of Two School Districts

by

Yujung Ko

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Dedication

To my parents,

For your relentless support and unfailing love

To Eunjung,

My baby sister and best friend, who always makes me laugh

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Abstract

Information-Seeking Behaviors of Teachers for Technology Integration: A Case Study of Two School Districts

Yujung Ko, Ph.D.

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Supervisor: Joan E. Hughes

The goal of this study aims to understand teacher information-seeking behaviors for technology-infused teaching and learning in two school districts. With technological pedagogical content knowledge (TPACK) as its conceptual framework, this study attempts to understand teacher information needs for technology integration in relation to technology knowledge (TK), technological content knowledge (TCK), and technological pedagogical knowledge (TPK). Using a mixed method case analysis approach, both quantitative and qualitative data were collected from teachers in the two technology-intensive school districts. Teachers completed an online survey that consists of information content, information sources, value ratings for online sources, technology usage, and demographic information. Upon completing the survey, a semi-structured interview was conducted with participating teachers to capture teacher online

information-seeking practices for technology integration in detail. The findings showed that teachers sought TCK information most frequently, followed by TK, and they expressed the need for high-quality, reliable resources. District A teachers were found to search information online less than District B teachers in all three areas of TK, TCK, and TPK, which can be explained by various supports and professional learning opportunities available in District A. For successful technology initiatives in schools and districts, proper supports for teachers need to be offered. By diversifying support mechanisms via different means and resources, teachers can develop knowledge and skills for technology integration.

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Chapter 1: Introduction

Background of the Problem

Technological advancement has spurred technology use in schools for better learning outcomes of students. With the increasing demand for teachers for technology-based instruction, state and national educational organizations established guidelines for teachers and students on how to utilize technology to keep up with expectations in society, some of which examples include National Educational Technology Plan (NETP; U.S. Department of Education, 2016), International Society for Technology in Education standards (International Society for Technology in Education, 2016, 2017), and the Partnership for 21st Century Learning skills framework (Partnership for 21st Century Learning, n.d.-a, n.d.-b).

Initial focus on technology integration was to provide sufficient technological infrastructure in schools (Lawless & Pellegrino, 2007). Policy reports on education technology published in between 1983 and 2003 made it clear that it is necessary to equip schools in the U.S. with technological equipment and infrastructure (Culp, Honey, & Mandinach, 2005). The continuous efforts have been made to secure technology, and the requirements for such technology integration materialized in schools today. For instance, many schools and districts installed Interactive White Board [IWB] in classrooms and implemented 1:1 iPad initiative.

However, growing concern among scholars has risen that technologies are less used, even in classrooms equipped with sufficient technologies (e.g., Cuban, 2001, 2013;

Ertmer & Ottenbreit-Leftwich, 2010). Teacher factors were at the heart of the issue of less used classroom technologies (Zhao & Frank, 2003). Specifically, previous studies pointed out teacher beliefs, attitudes, and knowledge as major factors that influence on teachers' use of technology in teaching and learning. That is, teachers' technology use in classrooms depends on their pedagogical beliefs (Ertmer, 1999, 2005; Ertmer & Ottenbreit-Leftwich, 2010; Kim, Kim, Lee, Spector, & DeMeester, 2013), perception and attitudes towards technology (Hew & Brush, 2007; Teo, 2011), and knowledge related to technology integration (e.g., Ertmer & Ottenbreit-Leftwich, 2010; Hew & Brush, 2007; Hughes, 2000, 2005).

Researchers have paid particular attention to teacher knowledge for technology integration (e.g., Ertmer & Ottenbreit-Leftwich, 2010; Hew & Brush, 2007; Hughes, 2000, 2005). After many attempts to understand teacher knowledge for technology-integrated teaching and learning (e.g., Hughes, 2000; Margerum-Leys & Marx, 2002), the technological pedagogical content knowledge (TPACK) framework was proposed by Mishra and Koehler (2006). Built upon Shulman (1986)'s pedagogical content knowledge (PCK), the TPACK framework introduced seven knowledge domains teachers have when technology is integrated in teaching and learning context—(a) technological knowledge (TK); (b) pedagogical knowledge (PK); (c) content knowledge (CK); (d) technological content knowledge (TCK); (e) technological pedagogical knowledge (TPK); (f) pedagogical content knowledge (PCK); and (g) technological pedagogical content knowledge (TPCK). Teacher knowledge, especially technology-related knowledge, became recognized as an important element for technology-integrated

teaching and learning (Cuban, 2001, 2013; Ertmer & Ottenbreit-Leftwich, 2010; Hughes, 2000), and structured, organized professional development trainings were provided to teachers to eliminate barriers teachers have for technology integration (Ertmer, 1999; Hew & Brush, 2007; Hixon & Buckenmeyer, 2009; Tsai & Chai, 2012) and to develop their ability for using technology in teaching practices (e.g., Hu & Garimella, 2014; Jaipal-Jamani, & Figg, 2015; Liu, 2013; Mouza, 2009; Walker et al., 2012).

About 80 % of a nationally representative sample of 3,159 teachers expressed their satisfaction on technology integration professional development (PD) programs (Gray, Thomas, & Lewis, 2010). However, recent empirical studies on PD for technology integration reported contradicting results to the most recent national survey. It was revealed that only 43% of teachers showed satisfaction on technology-related PD programs and activities they provided (An & Reigeluth, 2011). Teachers from an iPad initiative school indicated some of the PD sessions not only covered basic topics, such as operating iPad and introducing apps, but also were repetitive (Liu, Ko, Willmann, & Fickert, 2018).

A recent study on teacher learning documented teacher-created learning opportunities for technology integration (Jones & Dexter, 2014). The independent and individualized teacher learning was also reported in the national survey conducted by National Center for Education Statistics (NCES) (Gray et al., 2010). In addition, an increasing number of studies demonstrate that teachers are creating their own learning opportunities for professional purposes through online tools such as online communities, Twitter, Facebook, and blogs (e.g., Carpenter & Krutka, 2014; Hur & Brush, 2009;

Ranieri, Manca, & Fini, 2012). Information-seeking is a behavior involving seeking or using information to meet user's information needs. Teachers' information-seeking behavior can be understood as a way of self-initiated professional learning. By virtue of various online tools, the boundary of information-seeking is expanded to include online resources as well as traditional offline resources. Therefore, it would be worthwhile to explore, for technology-supported teaching and learning, what information teachers are seeking out online and where they find the information. A greater understanding of the most searched knowledge domains and sources may provide insight and recommendations for better supporting teachers for technology integration.

Purpose of the Study

The current study explores information-seeking practices of teachers for technology-infused teaching and learning in two school districts. With technological pedagogical content knowledge (TPACK) as its conceptual framework, this study attempts to understand teacher information needs for technology integration in relation to TK, TCK, and TPK. Using both quantitative and qualitative data, the study intends to answer the following research questions:

1. In terms of TK, TCK, and TPK, what online information do teachers seek about technology integration?
2. What online sources do teachers use for seeking information on technology integration?
3. How do teachers value the online information sources they use?

4. What are the similarities and differences of teachers' online information-seeking behaviors about technology integration among school districts, school levels, and subject areas?

Significance of the Study

Literature on information-seeking behavior of teachers has mostly focused on college faculty information-seeking behaviors (e.g., De Groote, Shultz, & Blecic, 2014; Gil, 2016; Hoppenfeld & Smith, 2014; Rupp-Serrano & Robbins, 2013) with only a few studies conducted with K-12 teachers (e.g., Perrault, 2007; Shipman, 2014). Even in the studies set in K-12 context, teachers information-seeking practices using online information sources are less examined. Moreover, teachers' online information-seeking practices for technology integration are rarely explored as most studies on information seeking practices of teachers are about general teaching content (Perrault, 2007) or pedagogical knowledge for instruction (Shipman, 2014).

The current study will examine teachers' online information-seeking behaviors for technology-based instruction. To date, there is little research conducted identifying teachers' information needs for technology integration especially when their school and districts are implementing technology initiatives. This research will make a contribution to literature on teacher information-seeking and provide practical recommendations for districts on how to support teachers for technology-supported teaching and learning.

Chapter 2: Review of Literature

This chapter reviews the relevant literature on teacher online information-seeking behaviors for technology integration. This review illustrates an increasing demand for teachers for technology-based instruction and the research conducted in relation to factors affecting to technology integration (e.g., teacher beliefs, attitudes, knowledge), technological pedagogical content knowledge (TPACK), technology integration, and professional development (PD). The second section examines the literature about teacher professional learning with a particular attention on how the web serves as a learning source. The third section explains information-seeking behaviors in education contexts. Finally, the last section summarizes the research gaps found in the literature.

Technology-Supported Teaching and Learning

Use of technology is becoming a natural part of classroom teaching and learning. The nationwide emphasis on improving student achievement through effective use of technologies in classrooms has been demonstrated in guidelines established by state and national educational organizations. Some examples of the guidelines include National Educational Technology Plan (NETP; U.S. Department of Education, 2016), International Society for Technology in Education standards (ISTE; International Society for Technology in Education, 2007, 2008, 2016, 2017), and the Partnership for 21st Century Learning skills framework (P21; Partnership for 21st Century Learning, n.d.-a, n.d.-b). Recently, the U.S. Department of Education (2016) has updated National

Educational Technology Plan (NETP). The 2016 NETP sets a vision aligned to the Activities to Support the Effective Use of Technology (Title IV A) of Every Student Succeeds Act (U.S. Department of Education, Office of Educational Technology, 2016) and provides recommendations and examples for educators including teachers, policymakers, administrators, and teacher preparation professionals on how to utilize technology to improve teaching and learning.

The International Society for Technology in Education (ISTE) outlines standards and performance indicators for technology integration for various target audiences such as teachers, students, administrators and coaches (International Society for Technology in Education, 2007, 2008, 2009, 2011, 2016, 2017). Specifically, according to the ISTE standards for educators (International Society for Technology in Education, 2017), educators should

- as a learner, continually improve their practice by learning from and with others and exploring proven and promising practices that leverage technology to improve student learning;
- as a leader, seek out opportunities for leadership to support student empowerment and success and to improve teaching and learning;
- as a citizen, inspire students to positively contribute to and responsibly participate in the digital world;
- as a collaborator, dedicate time to collaborate with both colleagues and students to improve practice, discover and share resources and ideas, and solve problems;

- as a designer, design authentic, learner-driven activities and environments that recognize and accommodate learner variability;
- as a facilitator, facilitate learning with technology to support student achievement of the ISTE Standards for Students; and
- as an analyst, understand and use data to drive their instruction and support students in achieving their learning goals.

The ISTE standards for students intend to foster students to become a: (a) empowered learner, (b) digital citizen, (c) knowledge constructor, (d) innovative designer, (e) computational thinker, (f) creative communicator, and (g) global collaborator (International Society for Technology in Education, 2016). Since its first introduction in 1998, the ISTE standards for students have evolved from "learning to use technology" to "using technology to learning," to "transformative learning with technology" (International Society for Technology in Education, 2007, 2016).

The Partnerships for 21st Century Learning (P21) is a nonprofit organization whose mission is to "serve as a catalyst and build collaborative partnerships among education, business, community and government leaders so that all learners acquire the knowledge and skills they need to thrive in a world" (Partnerships for 21st Century Learning [P21], n.d.-b). The organization suggests a framework for 21st Century Learning, which describes the skills and knowledge needed for students for future success in the 21st century (Partnerships for 21st Century Learning [P21], n.d.-a). The skills and knowledge include:

- content knowledge and 21st century themes

- learning and innovation skills
- information, media, and technology skills, and
- life and career skills.

The framework also addresses that the skills and knowledge elements are supported by four systems—(a) standards and assessments, (b) curriculum and instruction, (c) professional development, and (d) learning environment.

Altogether, the guidelines tell us the expectations society and educational organization bodies have for technology in education for teachers and students. It is expected for teachers to integrate technology for their teaching and for students to use technology in their learning. The 21st century learning is more than acquiring factual and procedural knowledge; rather, it has to do with developing conceptual understanding by being involved in complex academic content (Lawless & Pellegrino, 2007) and educational technology can promote this new type of learning. Toward this goal, in this study, I have adopted Hughes' (2013) conceptualization of technology integration, which means "the use of digital information communication technologies (ICT) by teachers and/or students that support constructivist and socio-constructivist instruction and learning (Cole, 1996; Greeno, 1989; Greeno, Collins, & Resnick, 1996; Vygotsky, 1978) of subject area content (e.g., math, science, social sciences, languages, etc.)" (Hughes, 2013, p. 493). That is, the ultimate goal of technology integration is to promote students' learning through creative and innovative instruction with a support of technology and teachers need to be encouraged to use technology in classrooms to achieve the learning goal.

Examples of technology integration. Literature reports positive effects on students learning outcomes when technologies are integrated in K-12 classrooms (e.g., Frey, Fisher, & Lapp, 2015; Keengwe, Schnellert, & Mills, 2012; Sadik, 2008). For example, digital storytelling projects through production and editing software of desktop helped students understand subject content better (Sadik, 2008). Another study on high school students in a 1:1 laptop initiative school found an increase in their academic engagement and learning outcome (Keengwe et al., 2012). More recently, with tablets, English teachers in an urban high school reported improvement in their students' academic performance as a result of iPad use in classrooms (Frey et al., 2015). The potential of technology in education, as demonstrated in these example research studies as well as others, has propelled technological infrastructure investment across K-12 schools.

Technology infrastructure. In the past years, technology in schools has been focused more on establishing infrastructure (Lawless & Pellegrino, 2007). Culp, Honey, and Mandinach (2005) reviewed education technology policy reports published in between 1983 and 2003. They concluded that all of the reports address the importance of having sufficient technology hardware in schools, insisting this is grounded in belief, shown in earlier reports (e.g., Office of Technology Assessment, 1988), that effective use of educational technology starts from having adequate technology in classrooms (Culp et al., 2005). The review study also extracted six key policy recommendations that have been consistently suggested over 20 years from the reports, one of which is "improve access, connectivity, and requisite infrastructure" (Culp et al., 2005, p. 286).

Accordingly, with national initiatives for using technology for teaching and learning, K-12 schools have been equipped with cutting-edge technologies. In recent years, Interactive White Boards (IWB) are placed on the wall in classrooms, and iPads are distributed to teachers and students under 1:1 initiatives. The NMC Horizon Report stated, in its 2013 report, that mobile learning would be adopted in one year or less (Johnson et al., 2013) and, as it expected, more than 60% of students in elementary and middle schools and 45% in high schools reported use of tablets in the classrooms (Seide, 2015). Furthermore, it seems that technology-based instruction would be more popular in the future with technology initiatives such as Bring Your Own Device (BYOD). In the 2014 NMC Horizon Report, BYOD was predicted to be a "time-to-adoption" in one year or less (Johnson, Adams Becker, Estrada, & Freeman, 2014) as well as in 2015 (Johnson, Adams Becker, Estrada, & Freeman, 2015). In K-12 schools, 75% of teachers reported using technology with students in classrooms on a daily basis, speculating increased use of technology in 2016-2017 school year (Nagel, 2016). However, even with satisfactory level of technology infrastructure, scholars documented that technology in classrooms is less used (e.g., Cuban, 2001, 2013; Ertmer & Ottenbreit-Leftwich, 2010) and teachers became a frequently cited factor affecting the technology use (Zhao & Frank, 2003).

Teacher pedagogical beliefs and attitudes. Researchers reached a consensus that leveraging the potential from technology-integrated lessons depends on teachers. They agreed that teacher characteristics such as pedagogical beliefs (Ertmer, 1999, 2005; Ertmer & Ottenbreit-Leftwich, 2010; Kim et al., 2013) and perception and attitudes towards technology (Hew & Brush, 2007; Teo, 2011) play an important role in deciding

whether to use technology in classrooms or not. For example, Ertmer and Ottenbreit-Leftwich (2010) examined literature to answer a lingering question of why technology is not achieving high levels of use in classrooms yet despite enough computer access and trainings. Through the lens of the teacher as a change agent, they selected pedagogical beliefs of teachers as one of the variables affecting technology-supported instruction and urged that teachers must change their mindsets with the notion that appropriate use of technology is essential for promoting student learning (Ertmer & Ottenbreit-Leftwich, 2010).

In an empirical study, Kim, Kim, Lee, Spector, and DeMeester (2013) found that teacher beliefs have a significant correlation with technology integration practices. In the study, the researchers reported that teacher beliefs about the nature of knowledge and learning and about effective ways of teaching are positively related, and those two teacher beliefs are also positively related to their technology-integrated teaching practices. The researchers suggested that, although this positive correlation does not necessarily mean causation, it is worth considering teacher beliefs for promoting technology integration (Kim et al., 2013). Regarding teacher attitudes toward technology, Teo (2011) studied the interactions among factors that affected teacher intention to use technology. A hypothetical model was developed and tested using structural equation modelling. The test results revealed that attitudes towards technology use is one of the significant factors on teachers' intention to use technology in teaching and learning (Teo, 2011).

Teacher knowledge. Another factor that has been reported to affect technology integration is teacher knowledge (e.g., Ertmer & Ottenbreit-Leftwich, 2010; Hew & Brush, 2007; Hughes, 2000, 2005). Many attempts have been made to understand knowledge teachers possess or develop when integrating technology in teaching and learning. For example, Hughes (2000) proposed "a model of the nature of teachers' independent learning about technology." In this model, on a basis of content knowledge (CK), pedagogical knowledge (PK), and pedagogical content knowledge (PCK), she added technology knowledge (TK), technology pedagogical knowledge (TPK), English-technology pedagogical content knowledge (E-T PCK), all of which English teachers may develop while learning for technology-supported instruction. From her definition, TK means "what does a teacher know about technology per se" and TPK means "what does a teacher know about how to use technology to support teaching and learning" (Hughes, 2000, p. 176).

Margerum-Leys and Marx (2002) also explored the construct of teacher knowledge in the realm of education technology. They used Shuman (1986)'s model of teacher knowledge that contains CK, PK, and PCK as their theoretical framework and focused on the three types of knowledge to capture the nature of teachers' educational technology knowledge. They used the term CK of educational technology to refer to "knowledge of the existence, components, and capabilities of various technologies"; PK of educational technology to refer to "knowledge of general strategies and the ability to apply those strategies to the use of technology"; and PCK of educational technology to refer to "knowledge which arises from experience with using technology for teaching and

learning and which in turn applies to the use of technology for teaching and learning" (Margerum-Leys & Marx, 2002, p. 430). While each term in Hughes (2000) and Margerum-Leys and Marx (2002)'s study were used somewhat differently, it can be loosely said that Margerum-Leys and Marx's CK of education technology is similar to Hughes' notion of TK, and Hughes' TPK conveys similar meaning with PK and PCK of Margerum-Leys and Marx.

Based on these earlier works on teachers' technology knowledge in teaching and learning, Mishra and Koehler (2006) proposed the technological pedagogical content knowledge (TPACK) framework (see Figure 1). The TPACK framework is built on Shulman (1986)'s pedagogical content knowledge (PCK) that explains teachers' knowledge base about instructional methods (i.e., pedagogical knowledge; PK) and about subject-specific area (i.e., content knowledge; CK) being used when they teach. The TPACK consists of seven knowledge domains that teacher will employ in teaching and learning with technology, and according to Mishra and Koehler (2006), each knowledge domain is defined as follows.

- Technology knowledge (TK): TK refers to knowledge about both traditional (e.g., chalk and blackboard, calculator) and more advanced technologies (e.g., the Internet, iPad) and "involves the skills required to operate particular technologies" (p. 1027).
- Content knowledge (CK): CK includes content-specific knowledge in the areas of teaching.

- Pedagogical knowledge (PK): PK is knowledge about general pedagogical practices or methods.
- Technological content knowledge (TCK): TCK is located between TK and CK and it is "about the manner in which technology and content are reciprocally related" (p. 1028).
- Technological pedagogical knowledge (TPK): TPK is where TK and PK overlap and deals with "existence, components, and capabilities of various technologies as they are used in teaching and learning settings, and conversely, knowing how teaching might change as the result of using particular technologies" (p. 1028).
- Pedagogical content knowledge (PCK): PCK is in the intersection of PK and CK and focuses on "knowing what teaching approaches fit the content, and likewise, knowing how elements of the content can be arranged for better teaching" (p. 1027).
- Technological pedagogical content knowledge (TPCK): TPCK is located at the heart of the knowledge circles where all three knowledge bases intersect and involves knowledge of all three TK, CK, and PK domains working together. It is "the basis of good teaching with technology" (p. 1029).

Some of TPCK examples include knowledge about how to use technology to help students learn a science concept that is known to be difficult to understand; about using technology for collaborative writing in English language arts.

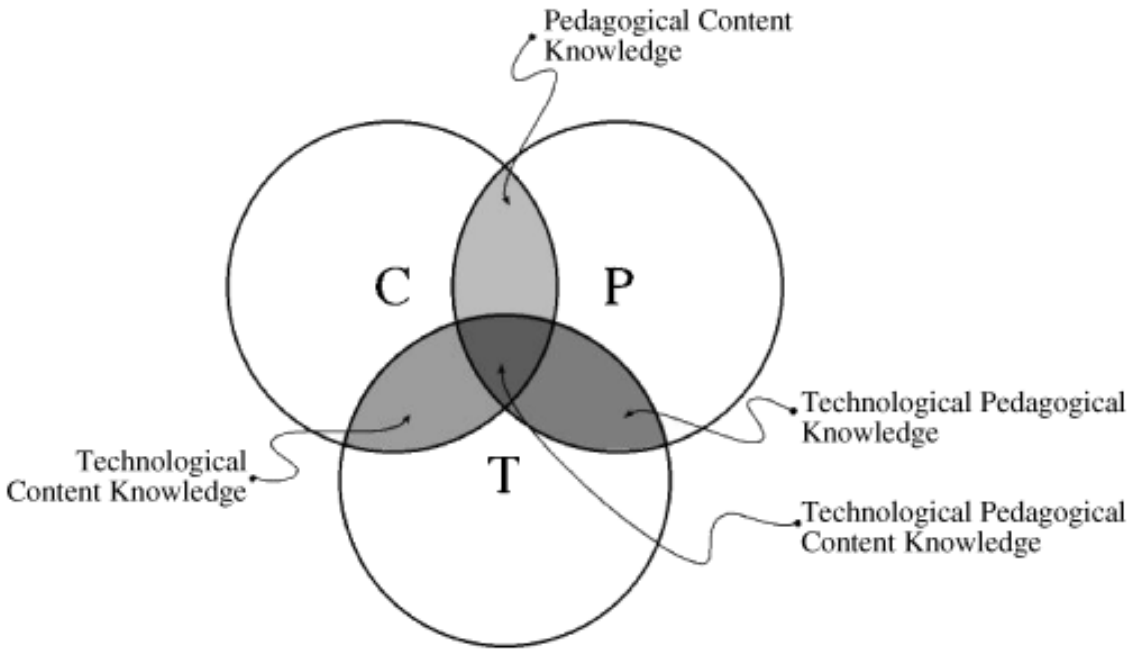

Figure 1: TPACK Framework (Mishra & Koehler, 2006)

The relationship between TPACK and technology-integrated teaching practices has been studied by many scholars. In earlier work, Hughes (2000) investigated the relationship between teachers' own learning experiences of technology and their teaching practice with technology. After identifying why and how four English teachers learned technology and taught lessons with technology, she reported that, although there were some variability in classroom use of technology by individual teachers, the teachers developed their knowledge about technology itself and how to use the technology in a teaching and learning environment, which refers to technology knowledge and technology pedagogical knowledge, respectively (Hughes, 2000). The four teachers, in the study, already possessed CK, PK, PCK, but not all of them had TK when they began

their teaching career. Once they developed TK, then it influenced the development of their TPK and TPCK (Hughes, 2000). She continued to emphasize, in her later work, that teacher knowledge such as CK, PK, PCK, TK plays an important role in developing technology-supported lessons (Hughes, 2005).

Researchers have especially focused on technology-related knowledge (i.e., TK, TCK, TPK, and TPCK), among seven knowledge bases in the TPACK framework, for technology integration in education. Ertmer and Ottenbreit-Leftwich (2010) asserted that teachers need to expand their TK across other knowledge domains such as CK, PK, and PCK to achieve effective use of technology in instruction. This is because knowing how to use technology tools does not necessarily lead teachers to use it in teaching and learning, which means there is a "gap between teachers' personal and instructional uses of technology" (Ertmer & Ottenbreit-Leftwich, 2010, p. 260). Likewise, Harris, Mishra, and Koehler (2009) underscored a need for teachers to possess TK, CK, PK, and their interrelastionships and for professional development programs to encompass those knowledge bases as learning about technology itself is not the same as learning how to use it in an instructional way. In short, the literature agrees to the necessity of teacher knowledge, especially technology-related knowledge, when technologies are integrated in teaching and learning context, and the degree of teacher knowledge, in turn, affects technology integration levels in instruction.

Levels of technology integration. When technology is used in classrooms, the level of integration matters. As mentioned earlier in the definition of technology integration, the technology integration does not merely mean using technology in

teaching and learning; rather, it has to be geared towards transformative, student-centered, and content-specific technology integration. That is, if a teacher uses PowerPoint slides containing text and a few images to lecture, there would be no difference between using the PowerPoint and using paper-based textbook. In this case, PowerPoint is used only to replace paper textbooks. In contrast, if a teacher shows an underwater live video of starfish in the ocean and has students research the starfish on the Internet, it would be a transformative way of integrating technology. This kind of learning is not possible with traditional learning materials and helps increase student engagement and learning outcomes.

Although observation on technology-based teaching practices is conducted less often in research, technology integration studies often reported basic level of integration in teaching and learning. Cuban (2001) conducted an extensive work on technology use in schools from PK-12 to university in Silicon Valley, California, where teachers and students have access to new technologies. He reported that, even in this technologically advanced area, "the overwhelming majority of teachers employed the technology to sustain existing patterns of teaching, rather than to innovate" (Cuban, 2001, p. 134).

Even more than 10 years after Cuban's work in 2001, it seems that the situation has not been changed much. Milman, Carlson-Bancroft, and Boogart (2014) found that teachers in a 1:1 iPad initiative elementary school were integrating iPads in interdisciplinary ways but in relation to "existing curricula to complement or enhance their lessons" (p. 124). Hughes, Ko, and Boklage (2017) also reported that some of high school STEM teachers in a 1:1 iPad environment were not able to reach higher level of

technology use in a transformative way. While some teachers demonstrated transformational use of technology in teaching and learning activities such as having students collect, identify, and upload data using apps during field trips, others used PDF and a cloud storage system (e.g., DropBox) on iPad instead of paper copy for distributing and collecting assignments (Hughes et al., 2017). Knowing about teachers' level of technology integration would provide insight on what teachers need to learn and how to support them for effective teaching and learning with technology. The previous studies necessitate teacher learning opportunities for technology-supported instruction to develop their abilities to integrate technology in teaching practices.

Professional development about technology integration. As the issue of equal distribution of digital resources in schools are being resolved (Lawless & Pellegrino, 2007), research is needed to understand the development of teachers who are capable of using technology to support 21st century teaching and learning. Previous studies have pointed out that having technology in hand does not necessarily lead teachers to take advantage of the technology to enhance student learning (Cuban, 2001; Donovan, Green, & Hansen, 2011; Ertmer & Ottenbreit-Leftwich, 2010; Hughes, Gonzales-Dholakia, Wen, & Yoon, 2012). Even for "digital natives," who are presumed to be able to easily integrate technology for teaching and learning purposes, research revealed that it is not always the case. Preservice teachers showed confidence in using technology, but they neither integrated technology during student teaching nor understood potential of technology for teaching practice (Teclehaimanot, Mentzer, & Hickman, 2011). Studies on preservice teachers continue to report that the digital native teacher candidates do not

possess sufficient knowledge and proficiency in using technology for educational purposes (Lei, 2009; Hughes, Ko, Lim, & Liu, 2015; So, Choi, Lim, & Xiong, 2012).

Barriers to technology integration. As evidenced from studies on technology-integrated teaching practices, not all teachers are able to achieve standards established for teachers and students in technology-supported instruction (e.g., Hughes et al., 2017; Milman, Carlson-Bancroft, & Boogart, 2014). Researchers tried to answer why technology is not used in schools as much as it is expected to be and suggested two probable causes—external and internal barriers (Ertmer, 1999, 2005; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012). External barriers, also known as first-order barriers (Ertmer, 1999) are extrinsic to teachers. This type of barriers includes lack of technology support, insufficient technology facility (Ertmer, 1999; Hew & Brush, 2007; Hixon & Buckenmeyer, 2009). Meanwhile, internal barriers, also known as second-order barriers (Ertmer, 1999), are intrinsic ones that are, for example, teacher beliefs, attitudes, knowledge, and skills (Ertmer, 1999; Hew & Brush, 2007; Hixon & Buckenmeyer, 2009). More recently, a third-order barrier is introduced in literature, which involves design thinking (Tsai & Chai, 2012). Tsai and Chai (2012) argue that lack of design thinking by teachers to develop technology-integrated lessons may hinder its successful implementation even after both first- and second-order barriers are eliminated. To help teachers overcome those barriers, more supports in a form of PD started to be given to teachers as a way to enhance teacher ability to use classroom technology in an effective way.

Professional development on technology integration. Professional development (PD) for teachers has been considered a primary means to improve teaching practices (Borko, Whitcomb, & Liston, 2009; Desimone, 2009; Lieberman & Mace, 2010). Specifically, with nation-wide enthusiasm to education reform initiatives, scholars share the view that teachers play a crucial role in achieving the reform, and thus, teacher professional development should be placed at the center of the reform activities (Borko & Putnam, 1995; Desimone, 2009; Garet, Porter, Desimone, Birman, & Yoon, 2001). Accordingly, numerous teacher professional development programs were enacted in past decades, and much research has been conducted including implementation of PD programs, evaluation of PD outcomes (Desimone, 2009; Garet et al., 2001; Wilson & Berne, 1999).

With technology initiatives in districts and schools, PD opportunities for technology-supported teaching and learning have been provided to teachers, aiming to improve teaching practices with technology. Previous studies made it clear that PD is one of the important factors that have an impact on teachers' technology use (Lawless & Pellegrino, 2007; Mouza, 2009) and examined the impact of technology integration professional development for practicing teachers (e.g., Hu & Garimella, 2014; Mouza & Barrett-Greenly, 2015). For example, Hu and Garimella (2014) explored the use of the iPad after a STEM teacher professional development programs. Teachers in this case study showed higher iPad proficiency and likelihood to adopt the iPad in teaching and learning after designing iPad-integrated lesson plans in the PD program. Similarly, Mouza and Barrett-Greenly's study (2015) confirmed that teachers, as a result of PD

focused on use of iPads and apps, were able to utilize iPads to broaden learning experiences of students through online content, artifact creation, and personalized instruction.

Specifically, with relation to technology-related knowledge, scholars paid attention to how to enhance TPACK of teachers through professional development (e.g., Jaipal-Jamani, & Figg, 2015; Liu, 2013). Liu (2013) explored how a collaborative PD program changed instructional strategies elementary school teachers employed for technology integration. Six elementary school teachers participated in the PD program, and the researcher documented the teachers' teaching activities and discussions through observation and focus group interviews. The PD concentrated on developing TPACK through lesson planning, interactions among the participating teachers for the lesson plans, teaching practices, and peer observations. The teachers who used to have TK but did not effectively integrate the technology for content teaching (e.g., lecturing with Interactive White Board [IWB]) became capable of combining their knowledge base of pedagogy and subject content area after peer feedback on lesson plans and classroom teaching. With the finding, Liu (2013) asserted the importance of TK and recommends that teacher educators need to make an effort to improve teachers' TK and facilitate peer observation and focus group interviews among teachers.

In another study, Jaipal-Jamani and Figg (2015) conducted a naturalistic case research to describe an effect of a TPACK-based workshop on teachers' TPACK development. The teacher participants were asked to plan and implement a blog activity for teaching science. The analysis of various data sources, including field notes,

classroom observations, interviews, and lesson artifacts, indicated that the teachers were able to develop TPACK in science instruction as they had an opportunity to create a technology-integrated lesson and apply it to classroom teaching immediately.

Regarding PD activities for educational technology, representative samples of teachers in the United States indicated satisfaction with their PD programs (Gray et al., 2010). In this survey research conducted by National Center for Education Statistics (NCES), the teacher respondents who participated in technology PD trainings in a previous year were asked to answer if they agree or disagree to the statements about PD activities. 81% of the teachers reported that PD met their goals and needs. Additionally, 88% of them agreed on a statement, "It [PD] supported the goals and standards of my state, district, and school" (Gray et al., 2010, p. 19). In contrast, however, more recent empirical studies on PD for technology integration contradict the national survey. For instance, An and Reigeluth (2011) reported that 43% of K–12 teachers out of 126 respondents in northeast Texas and southwest Arkansas in the United States showed satisfaction on current technology-related PD programs and activities. The teacher participants also pointed out the major weakness of PDs as being too broad, not focused on subject content, and one-shot training with too much information (An & Reigeluth, 2011). In another study, teachers whose school implemented a district-wide iPad initiative indicated, after a year-long PD, that some of the PD sessions covered only the basic level of technology integration (e.g., how to navigate iPad, introduction of apps) and were repetitive (Liu et al., 2018). Moreover, a qualitative study on teachers' learning by Jones and Dexter (2014) showed that teachers created their own learning opportunities

for technology integration in addition to district-initiated, structured PD program and professional learning community (PLC). The teachers not only formed a learning community with colleagues but also pursued learning independently and individually by searching for resources online through Google, YouTube or Teacher Tube (Jones & Dexter, 2014). The independent and individualized teacher learning was already evidenced in the NCES survey (Gray et al., 2010). 61% of the teachers responded that PD activities helped them integrate technology better in instruction whereas 78% of them contributed to independent learning for their effective technology integration. In short, previous research suggests that, in spite of PD trainings provided, teachers express insufficient supports and they are still in need of more learning opportunities.

Teacher Self-directed Professional Learning

Teachers are creating and/or pursuing learning opportunities for their own professional growth (Carpenter & Krutka, 2014; Duncan-Howell, 2010; Hur & Brush, 2009; Lieberman & Mace, 2008; Lortie, 1975; Tsai, Laffey, & Hanuscin, 2010; U.S. Department of Education, 2013). Studies on teacher learning document teachers are voluntarily engaged in learning activities that are neither mandated nor required for them to participate through diverse online tools and sources (e.g., Carpenter & Krutka, 2015a; Hur & Brush, 2009; Jones & Dexter, 2014).

Web as a learning source. The web has created a lot of different ways for teachers to be involved in professional learning. Previous studies on teachers' learning reported professional learning opportunities that online tools can provide as a main

reason for why teachers, with no obligation, participate in online communities and networks (e.g., Carpenter & Krutka, 2014; Duncan-Howell, 2010; Hur & Brush, 2009; Ranieri et al., 2012; Visser, Evering, & Barrett, 2014). For example, Hur and Brush (2009) examined three communities for K-12 teachers to find reasons for their participation in the self-generated online communities. They interviewed 23 teachers who engaged in the learning activities within the online communities and analyzed postings teacher created in the communities. The analysis results indicated five major reasons, which are: "(a) sharing emotions, (b) utilizing the advantage of online environments, (c) combating teacher isolation, (d) exploring ideas, and (e) experiencing a sense of camaraderie" (Hur & Brush, 2009). Duncan-Howell (2010) also confirmed that teachers participated in online communities for their professional learning, and the communities were considered as a meaningful tool among the teachers.

Studies on self-directed professional learning of teachers with Web 2.0 are beginning to expand its research area as more teachers are using tools such as Twitter and Facebook for the purpose of professional learning. In a study that examined educators' use of Twitter, Carpenter and Krutka (2014) found that the principal reason for Twitter activity among the educators including teachers is professional learning followed by reducing isolation and searching for community. In a subsequent study, the researchers narrowed down the educator participants to those who teach English, and the analysis yielded same results that the most popular use of Twitter was for their professional learning (Carpenter & Krutka, 2015b).

In case of Facebook, Ranieri, Manca, and Fini (2012) surveyed founders and members of five Italian Facebook groups to investigate why and how they are involved in the groups. The five Facebook groups were categorized into two types, which are generic and thematic. Generic groups are characterized by its main goal of sharing "experiences related to schools in general" whereas thematic groups have certain thematic areas, such as using Web 2.0, learning support, and learning disabilities (Ranieri et al., 2012). The authors analyzed the data collected from 1107 survey respondents, and concluded that the participants showed different motivations depending on the type of groups—generic and thematic (Ranieri et al., 2012). That is, for those who subscribe to a generic group whose main purpose is to share experiences in schools, sharing information on ideas and projects was more important. In contrast, keeping informed on group topics (in this case, learning disabilities) was identified as a main motivator to participants in a thematic group that has a particular topic.

Practitioner-based literature also explains how the new forms of technologies in a digitally networked world can and should be used for teachers' professional learning. For instance, Wong (2013) describes how educators can be connected in order to construct knowledge, collaborate, and interact with like-minded educators through Twitter, listservs, blogging, digital portfolios, and RSS feeds. As a whole, from the previous works, it is evident that the web provides numerous ways for teachers to pursue professional learning by exchanging and developing ideas, information, and knowledge.

Information-Seeking Behavior

Information-seeking is understood as a behavior that a person seeks and uses information to meet the user's information needs (Bitso & Fourie, 2012; Foster, 2004; Ikoja-Odongo & Mostert, 2006). Research on information-seeking in the field of education has been conducted in terms of the effects of library instruction and services provided (e.g., Shipman, Bannon, & Nunes-Bufford, 2015), information-seeking habits of educators in K-12 (e.g., Normore, 2011; Perrault, 2007; Shipman, 2014) and in higher education (e.g., Gil, 2016; Hoppenfeld & Smith, 2014; Rupp-Serrao & Robbins, 2013) or students in middle or high school (e.g., Chung & Neuman, 2007; Larsen & Martey, 2011) and undergraduate (e.g., Corbett, 2010; Komissarov & Murray, 2016).

Regarding information-seeking behavior of teachers, a considerable body of literature explored college faculty information-seeking behaviors. Examples of information-seeking studies focused on faculty encompass a wide range of disciplines from education (e.g., Rupp-Serrano & Robbins, 2013) to business and economics (e.g., Gil, 2016; Hoppenfeld & Smith, 2014), to health science faculty (e.g., De Groote et al., 2014), to natural science and engineering (e.g., Engel, Robbins, & Kulp, 2011). Those studies investigated information-seeking behaviors of academic professionals by collecting data on, for example, frequency of information-seeking, evaluation on resources and services provided to the faculty, and usage patterns of online and printed resources.

Less studied are information-seeking practices of educators in K-12 context. Only a few studies, to date, have been conducted to describe practicing K-12 teachers'

information-seeking behaviors. Shipman (2014)'s study intended to provide a description of inservice teachers' information-seeking habits for professional practice. The survey, answered by 222 K-12 teachers, revealed that teacher participants most frequently seek information about class exercises or project (90%), followed by lesson planning (84%). The most used sources for information-seeking was news information (91.7%) among six types of information sources—entertainment/popular, government publications, news information, professional/trade publications, scholarly/research journals, and social media/online discussion. In an exploratory mixed method study, Perrault (2007) reported that biology teachers used various forms of online information sources, which include search engines, web sites, digital libraries, online databases, and electronic discussion lists, for instructional planning. However, it was also found that the teachers did not use educational resources, such as digital libraries, online periodical databases, and electronic discussion lists, that are designed for teaching and learning activities compared to the other resources (Perrault, 2007). No research has examined PK-12 teachers' information-seeking behaviors relating to learning about technology integration.

Gaps in Research

Previous literature on information-seeking behaviors in education attempted to shed light on educators' experiences in the information-seeking activities. Nonetheless, while abundant research has been conducted on academic professionals at college (e.g., De Groote et al., 2014; Gil, 2016; Hoppenfeld & Smith, 2014; Rupp-Serrano & Robbins, 2013), there is a dearth of information about K-12 teachers' information-seeking. In

particular, among the teachers, less researched are their seeking practices of online information for the purpose of professional learning. A previous study revealed a variety of information sources used by teachers with news information as the most popular source (Shipman, 2014), but the sources included both online and offline-based materials. Even with a study whose scope of information sources are limited to online (Perrault, 2007), the range of sources included only five (i.e., search engines, web sites, digital libraries, online databases, and electronic discussion lists), which are not wide enough to accommodate diverse information sources available online now.

Furthermore, teachers' online information-seeking practices for technology integration are rarely studied. In most cases, the information seeking is about general teaching content such as presentation materials, graphics (Perrault, 2007) or pedagogical knowledge for class exercises, lesson planning, and assessment (Shipman, 2014). Given (a) an increasing demand for teachers to integrate technology for teaching and learning, (b) the inadequacy or lack of technology professional development available to teachers in PK-12 schools, and (c) more teachers engaging in self-directed professional learning, it is worthwhile to explore content and sources of teachers' online search practices for technology-supported instructions. Moreover, the current study is expected to provide practical recommendations to districts and teacher educators on how to support teachers for technology-supported teaching practices with a better understanding on teachers' information needs.

Chapter 3: Methodology

This study explored teachers' online information-seeking experiences for technology-based teaching and learning. The overarching goals of the study were to describe characteristics of teachers' search activities when they are searching for information online regarding technology integration and to identify the technology integration information content and sources. This chapter begins with theoretical perspective and research framework that inform the study and provides information on participants, instruments, procedure for data collection, and data analysis.

Theoretical Perspective

The current research study intended to understand reality that is complex and socially constructed by individuals. Thus, I framed the study using an interpretive, constructivist perspective. An interpretive approach aims to gain an understanding of "how individuals experience and interact with their social world" (Merriam & Associates, 2002, p. 4). Within an interpretivist theoretical perspective, the study applied constructivist epistemology. The constructivist epistemology is to describe individual teachers' perspectives and experiences (Koro-Ljungberg, Yendol-Hoppey, Smith, & Hayes, 2009). Using the interpretivist, constructive approach, I attempted to understand teacher information-seeking behaviors for technology-infused teaching and learning by surveying and interviewing with individual teachers.

Research Framework

This study utilized a mixed method case analysis approach utilizing both quantitative and qualitative data. From the mixed method approach, I was able to provide a better understanding on the research topic, taking advantage of structured quantitative data and detailed information through qualitative inquiry (Creswell, 2003). In addition, I employed a case analysis approach to compare two school districts and its embedded cases of schools (i.e., elementary, middle, and high school) and subject areas. This enabled me to "gain an in-depth understanding of the situation and meaning for those involved" with insights that "can directly influence policy, practice, and future research" (Merriam, 2001, p. 19). Specifically, teacher technological pedagogical content knowledge (TPACK) (Hughes, 2000; Margerum-Leys & Marx, 2002; Mishra & Koehler, 2006) framework helped situate this study on teacher online information-seeking practices for technology integration.

Technological pedagogical content knowledge (TPACK). The technological pedagogical content knowledge (TPACK) framework (Hughes, 2000; Margerum-Leys & Marx, 2002; Mishra & Koehler, 2006) provides a typology of knowledge that teachers are required to possess for technology-integrated teaching and learning. With the TPACK as a conceptual framework, I specifically focused on three knowledge domains of TK, TCK, and TPK for identifying teachers' needed knowledge domains for technology integration. Previous studies evidenced the important role of TK, TCK, and TPK playing out for successful technology integration (e.g., Hughes, 2000; Ertmer & Ottenbreit-Leftwich, 2010). Thus, this study attempted to explore most searched technology-related

knowledge areas of teachers in two technology-intensive school districts for technology-infused teaching and learning. I expected to provide practical recommendations on how to support teachers for technology-based teaching and learning by identifying which knowledge bases, among TK, TCK, and TPK, teachers seek out most and least online and by comparing cases of school districts, school levels, and subject areas.

Research Questions

The guiding question of this mixed methods exploratory case study was: In two school districts, what is the nature of teacher online information-seeking experiences for technology integration? The research questions were as follows:

1. In terms of TK, TCK, and TPK, what online information do teachers seek about technology integration?
2. What online sources do teachers use for seeking information on technology integration?
3. How do teachers value the online information sources they use?
4. What are the similarities and differences of teachers' online information-seeking behaviors about technology integration among school districts, school levels, and subject areas?

Participants

Participants for the current study included K-12 teachers. The study was restricted to teachers teaching any subject area in K-12 schools (i.e., elementary, middle, and high

schools) who had done an online search for information about technology-supported teaching and learning.

The participants were recruited from two school districts. District A is located in suburban area with 10 schools and its size is between 5,000 – 9,999. Approximately 2 % of students are reported to be economically disadvantaged and majority of students (approximately 74%) are white as of 2016. District A had a teacher to computer ratio of 1:1, students to computer ratio of 1.85:1 in 2010 and began a 1:1 iPad initiative in 2012. District B is also located in suburban area. It has 13 campuses and belongs to 5,000 – 9,999 category. About 70% of students are economically disadvantaged and the dominant student populations are Hispanics (approximately 65%) and African Americans (approximately 20%). In District B, as of 2014, all teachers were provided laptops and iPads whereas the student to computer ratio was 3:1 with all high school students having a 1:1 student:iPad ratio and 1-5 iPads per classroom in the majority of other school campuses. Overall, the two districts had similarities in size and a heavy technology focus in all or some schools in the districts. At the same time, they had stark differences in SES, and ethnicity distributions of students.

An invitation link to online survey was emailed to teachers in Districts A and B in April 2017. Initially, 397 survey respondents, 321 from District A and 76 from District B, were recorded, meaning 397 respondents opened the survey (see Table 1). However, it should be noted that the survey questionnaires were voluntary-based response, and thus, each question or section of the online survey has a different number of respondents. That is, teacher participants were allowed to leave the survey at any point during the

questionnaire, and the number of respondents showed a pattern of decreased participation as the survey proceeded from TK to TCK, to TPK, to demographic information section.

Table 1: Number of Respondents by Survey Section

	Intro	TK	TCK	TPK	Demography
District A	321	239	197	163	142
District B	76	46	43	37	29

Ultimately, 175 respondents from two school districts completed the entire online survey questionnaire. 143 respondents from District A answered the online survey and 11 teachers participated in a follow-up interview. In District B, 32 respondents completed the online survey and 3 teachers were interviewed (see Table 2).

Table 2: Number of Study Participants by District

	District A				District B				
	Female	Male	Gender Unknown	Total	Female	Male	Gender Unknown	Total	Total
Survey	97	45	1	143	23	6	3	32	175
Interview	7	4	0	11	1	2	0	3	14

As of 2015, the number of full time teachers was approximately 582 in District A and 563 in District B. Thus, around 24.6% and 5.7% of respondents, from District A and District B, respectively, completed the online survey. As demographic questions were shown at the end of the survey, Table 2 through Table 4, all of which contain demographic information (e.g., gender, school level), were presented based on the number of study participants who completed the survey entirely. When possible,

demographic information was manually added. For example, a survey respondent reported teaching 2nd grade but did not indicate the school where the respondent teaches. In this case, the respondent was added to a group of elementary school teachers.

Table 3: Number of Study Participants by School

		School Level	Survey	Interview	Total
District A	School 1	ES	7	1	8
	School 2	ES	7	1	8
	School 3	ES	8	1	9
	School 4	ES	2	0	2
	School 5	ES	16	0	16
	School 6	ES	10	1	11
	School 7	MS	24	2	26
	School 8	MS	2	2	4
	School 9	HS	66	3	69
	Unknown		1	0	1
District B	School 1	ES	2	0	2
	School 2	ES	0	0	0
	School 3	ES	4	1	5
	School 4	ES	9	1	10
	School 5	ES	4	1	5
	School 6	ES	0	0	0
	School 7	ES	0	0	0
	School 8	ES	4	0	4
	School 9	ES	0	0	0
	School 10	MS	1	0	1
	School 11	MS	5	0	5
	School 12	HS	0	0	0
	School 13	HS	0	0	0
	Unknown		3	0	3

Note. ES = Elementary School; MS = Middle School; HS = High School.

Most of the survey respondents in Districts A and B were teaching in elementary (n = 74) or high school (n = 66) (see Table 4). Fewer number of middle school teachers (n = 32) completed the online survey.

Table 4: Number of Survey Respondents by District and School Level

	School Level			
District	Elementary	Middle	Secondary	Total
A	50	26	66	142
B	24	6	0	30
Total	74	32	66	172
%	43.0	18.6	38.4	100

Instruments

The research questions of the current study were answered by the two data sources: a survey and semi-structured interview.

Survey. The participants were asked to complete an online survey questionnaire (see Appendix A). The survey was divided into five sections: information content, information sources, value ratings for sources, technology usage of teacher and students, and demographic information.

Information content. The participant teachers were asked to check the content categories of information and the frequency of each content they sought out online for technology-supported teaching and learning. This section of the survey was adopted and modified from coding schemes of TK, TCK, and TPK from Mouza (2011) and Hughes, Ko, and Lim (2018)'s study. Both studies developed teacher knowledge evidence items to code qualitative data. As the TK, TCK, and TPK coding schemes in the studies were

designed to code qualitative data such as classroom observation, teacher narratives, interviews, there were evidence items that are not relevant to the study. For example, one of TK items was *using appropriate vocabulary*, which did not apply to the context of the current study. Thus, I dropped this TK items in the list of information contents. In other cases, I modified the knowledge items in the previous studies to accommodate and reflect online nature of information-seeking behavior. For instance, for TPK survey items, *knowing about the existence of a variety of tools for particular tasks* in Mouza (2011)'s study was modified to *technologies for lesson planning preparation* in the current study.

Example survey items include *how to use technology hardware, software, and/or apps* for TK, *how to use subject-specific technologies in my subject area(s)* for TCK, and *how to motivate students through technology* for TPK. The online information content section encompasses 18 items in a closed-ended format. The participants were asked to provide their frequency of searching for each content on a 5-point scale from never, once or twice in a month, once or twice in a week, three to four times in a week, and daily or more often (see Appendix A).

Information sources. For sources of online information, participants provided sources where they sought online information from a list of online tools and resources. This section of the survey included a wide variety of online information sources and allowed respondents to add resources that were not listed in the survey. The survey items were expanded upon items from Shipman, Bannon, and Nunes-Bufford (2015)'s study, whose survey questions were added and developed from Neely (2000) and *Information Literacy Standards For Teacher Education* (Association of College & Research

Libraries, 2011). They were also modified to serve the purpose of the current study. Thus, information sources such as teacher(s) in your department, school librarian(s), college textbooks were dropped because, for the current study, I intended to limit the scope of tools and resources that were online as a form of media (e.g., text, photo, video, audio) and contained information and knowledge. After identifying the information sources, the respondents indicated the frequency of using each information source on a 5-point scale from 1 (*never*) to 5 (*daily or more often*) (see Appendix A).

Value rating for online sources. Participants were asked to assess their perceived value of each online source they reported using for information searches. In this section of the survey, the online sources that participants indicated they had used in the previous section (i.e., information sources) were shown in a list. Teachers indicated how valuable they thought each online source was on a 5-point rating scale, with 1 being least valuable and 5 being most valuable (see Appendix A).

Technology usage of teacher and students. Questions about technology integration were asked to gain a basic understanding of technology-related conditions of school in which the participant worked. The questions in this section were about technology facilities teachers and students were using and the frequency of its usage (see Appendix A).

Demographic information. Demographic information of the participants was gathered as a part of the survey questionnaire. The demographic information included: age, gender, teaching years, school level, subject area, ethnicity, and highest level of education (i.e., Bachelor's, Master's, Ed.S., and Ed.D./Ph.D.). In addition, questions

asking the teachers' willingness to participate in future interviews and contact information were included as well (see Appendix A).

Table 5 provides a summary of quantitative data that was collected for the study.

Table 5: Quantitative Data Summary

Section Topic	Description	Measuring scale
Information content (18 items)	Content of information that teachers seek out online regarding technology integration. Items are based on TK, TCK, and TPK.	5-point scale 1 = never 2 = once or twice in a month 3 = once or twice in a week 4 = three to four times in a week 5 = daily or more often
Information sources (18+ items)	Sources of information that teachers seek out online regarding technology integration	5-point scale 1 = never 2 = once or twice in a month 3 = once or twice in a week 4 = three to four times in a week 5 = daily or more often
Value ratings for online sources	Teachers' perceived value of each online information source	5-point scale 1 = not valuable 2 = somewhat valuable 3 = valuable 4 = very valuable 5 = extremely valuable
Technology usage	Information about technology facility usage by teachers and students	5-point scale 0 = Not available (to students) in my school/classroom 1 = never 2 = once or twice in a month 3 = once or twice in a week 4 = three to four times in a week 5 = daily or more often
Demographic information	Information about age, gender, teaching years, school level, subject area, ethnicity, and education level	N/A

Semi-structured interview. Semi-structured interviews were conducted with 14 teachers who completed the survey and agreed to take part in an interview to further explore the teachers' online information search experience in the two districts (see Table 6). The interviews lasted approximately an hour in average and were digitally recorded.

Table 6: Demographics of Interviewees

	Pseudonym	District	School Level	Teaching Subject(s)
1	Naomi	A	HS	Foreign Language
2	Ethan	A	HS	Science
3	Wyatt	A	HS	Social Studies
4	Taylor	A	MS	English/English Language Arts
5	Amy	A	MS	Mathematics
9	Liam	A	MS	Social Studies
10	Iris	A	MS	English/English Language Arts
6	Mia	A	ES	English/English Language Arts
7	Hailey	A	ES	All subjects
8	Jeremy	A	ES	English/English Language Arts
11	Claire	A	ES	Other
12	Kate	B	ES	All subjects
13	Frank	B	ES	Math & Science
14	Dylan	B	ES	Other

Note. HS = High School; MS = Middle School; ES = Elementary School.

According to Merriam (2009), semi-structured interviews are useful to provide rich description of phenomena. The interviews were conducted after the survey period ended and followed a semi-structured interview protocol (see Appendix B). Interview questions included but were not limited to the following: the meaning of technology integration for teaching and learning to teacher participants, technology integration level expected by school and/or district, most recent online information search for technology-

integrated instruction, changes in online information-seeking behaviors over time, most valuable online resources, most needed information for technology-based teaching and learning, and support strategies for the needs.

Procedure

Survey invitations were distributed from the principal of each school to individual teachers' school email accounts with a link to the online survey, starting in April 2017. The participants first responded to online survey hosted in Qualtrics on the UT servers. Reminders were sent two times to promote participation during the three to four weeks of survey data collection.

With those who agreed, the interviews were conducted in May 2017. Each interview was individually scheduled at the participant's convenience. The interviews were performed at school campus of each participant and digitally recorded for reliability and accuracy.

Data Analysis

This mixed methods exploratory case study first analyzed quantitative data using descriptive analysis, t-test, and one-way ANOVA. Survey responses of teacher participants were analyzed as a whole and compared by school districts, school level, and subject areas. Second, interview data of teachers was analyzed by using a constant comparative method to describe characteristics of teacher online information-seeking behaviors by school districts.

Quantitative data. Descriptive analysis was conducted to understand characteristics of each case (i.e., school districts, school level, and subject areas). Frequency scores for content and sources of online information teachers sought out were calculated. Mean scores were also computed based on the frequency scores. The calculated frequency and mean scores were used to compare patterns of teacher online information-seeking behaviors at district, school, and subject area level. Value rating scores were analyzed employing descriptive statistics and used to compare cases of districts, schools, and subject areas. As the survey was voluntary-based, the analysis in each knowledge area (i.e., TK, TCK, and TPK) was performed with a different number of respondents.

T-test and one-way ANOVA were conducted to compare groups across the two school districts and three school levels (i.e., elementary, middle, and high school), respectively, using mean scores from frequency of searching online information content. The comparison among four subject area groups was not performed due to small number of participants and data being skewed and kurtoic. Frequency scores of each item under TK, TCK, and TPK were averaged to represent scores of TK, TCK, and TPK, respectively, and the TK, TCK, and TPK mean scores were used for the statistical analysis. The comparison groups included districts (e.g., District A vs. District B) and school level (e.g., elementary school vs. middle school vs. high school). Before conducting t-test and ANOVA, I examined if the following assumptions were met (Borich, 2012).

1. The scores for each population represented in the study should be normally distributed.
2. The scores for the dependent variable should be interval or ratio scales.
3. Population variances must not be significantly different.

Assumption 2 was ensured as survey of the current study employed interval scales to indicate frequency. For t-test, I used the pooled standard error when equal variances were assumed and the unpooled standard error when it was not. Also, when assumption 1 or 3 was violated, it was dealt with appropriate methods, which were Welch's ANOVA for one-way ANOVA.

Qualitative data. The semi-structured interview data analysis employed a constant comparative method. The constant comparative method was originally developed by Glaser and Strauss (1967) for grounded theory (Merriam, 2001). However, many scholars who are not developing grounded theory have adopted the method as its basic strategy is compatible with all qualitative research that are characterized as inductive and concept-building (Merriam, 2001). All interviews were transcribed first. With the transcripts, I used the constant comparative method and created categories to capture characteristics of teacher online information-seeking practices while constantly comparing one incident to another in raw data (Merriam, 2009). The tentative categories then were compared to other categories until no categories reflected similar meaning.

Trustworthiness

To build trustworthiness of the study through valid and credible data, I employed the following strategies throughout my research. First, I collected data from survey and interviews. By triangulating data sources, I was able to cross check the data, and it ensured internal validity. Second, I recorded interviews so that it provides credibility and guarantee authenticity (Lincoln & Guba, 1985).

Researcher Positionality

I remember searching online resources for effective instructional strategies and technology-based teaching and learning practices for my content area as a beginning teacher. Despite enthusiasm to improve my teaching practices, I did not know what to do and where to ask for help and ended up searching information online. Though my teaching life as a professional teacher lasted only for a short period of time, the experience led me to have an overarching research interest of finding ways to support pre-service and inservice teachers through teacher preparations and professional development. While working on research studies on teacher use of iPad, I found that teachers do not have enough time to play around with new technology and technology is often integrated at basic levels as a form of substituting existing tools. Furthermore, even with professional development trainings provided by districts or schools, teachers felt the trainings were not sufficient to cover various topics at different technological levels. The findings from the iPad teacher studies (Hughes et al., 2017; Liu et al., 2018) led me to research what kind of information teachers seek online through which sources when they

use technology for teaching and learning in classrooms. As a former teacher who struggled to enhance teaching practices with technology, I expected, through my study, to make a contribution to support current teachers for effective technology integration.

Chapter 4: Results

This research examined teachers' online information-seeking experiences for technology-based teaching and learning. This chapter reports research findings that answer the following research questions:

1. In terms of TK, TCK, and TPK, what online information do teachers seek about technology integration?
2. What online sources do teachers use for seeking information on technology integration?
3. How do teachers value the online information sources they use?
4. What are the similarities and differences of teachers' online information-seeking behaviors about technology integration among school districts, school levels, and subject areas?

Online Information Search

This section illustrates how frequently teachers sought information online in relation to technology integration by knowledge type. The knowledge types include technological knowledge (TK), technological content knowledge (TCK), and technological pedagogical knowledge (TPK). For each knowledge type, I report the overall frequency mean scores, which represent how many times teachers sought information online about TK, TCK, and TPK. The mean scores were also compared by district level, school level, and subject area (i.e., mathematics, science, social studies, and English).

Technological knowledge (TK). The technological know-how (TK) is information about a technical object, such as a computing device, software, or printer, and/or how these objects technically work. Examples of online searches for technical know-how include: searching for 3D printers, searching for how to connect project, searching for how to make a short movie, and searching for background information on what virtual reality is. Among 397 survey respondents who opened the survey, 285 respondents finished answering TK section of the survey. Overall, teacher participants sought technological know-how approximately once or twice in a month (M = 2.10, SD = 0.87).

By district. Teachers in Districts A and B reported finding technology-related information online approximately once or twice a month. However, District A teachers reported searching online information about technology knowledge (M = 2.09, SD = 0.81) less than District B teachers who reported doing more online searches for technology knowledge (M = 2.14, SD = 1.14) (see Table 7).

Table 7: Online Search for TK by District

District	*n*	*M* [a]	*SD*
A	239	2.09	0.81
B	46	2.14	1.14

Note. [a]5-point scale from 1 (*never*) to 5 (*daily or more often*)

An independent sample t-test was conducted to statistically compare technology information seeking frequency between teachers in Districts A and B. Before conducting

the t-test, normal distribution assumption for t-test was assessed. As the assumption was met, the t-test for difference in technological information search between the two districts teachers was performed. The results of the t-test using the unpooled standard error showed no statistical significance for the difference in teachers' online search for technology-related information between the two districts, $t(54) = -.27$, $p = .787$.

By school level. Comparison of online information search frequency was conducted with elementary, middle, and high school teachers across the two districts. The results indicated that middle school teachers most frequently sought technology-related information online ($M = 2.14$, $SD = 1.09$) (see Table 8). This means middle school teachers reported searching online information about technology knowledge more than once or twice in a month. Teachers in elementary and high school reported similar frequency for technology information search with a slightly higher score of elementary school teachers ($M = 2.09$, $SD = 0.91$) than that of high school teachers ($M = 2.08$, $SD = 0.77$).

Table 8: Online Search for TK by School Level

School level	*n*	*M* [a]	*SD*
Elementary	74	2.09	0.91
Middle	32	2.14	1.09
High	66	2.08	0.77

Note. [a]5-point scale from 1 (*never*) to 5 (*daily or more often*)

A one-way ANOVA was performed to investigate the difference among the three groups of elementary, middle, and high school teachers. The assumptions for ANOVA,

normal distribution and homogeneity of variance, were assessed before running the ANOVA analysis. The data was normally distributed, but the *Levene's F* test indicated that the equal variance assumption was not met ($p = .040$). Thus, the Welch's ANOVA was used to account for heterogeneous variance across groups. The Welch's ANOVA analysis showed no significant difference in the groups, *Welch's* $F(2, 78) = .05$, $p = .956$.

By subject area. Among middle and high school teacher participants, most teachers ($n = 20$) taught English or English Language Arts. Next most frequent was science ($n = 19$), social studies ($n = 17$), and mathematics ($n = 14$) (note that there are several middle teachers who reported to teach more than one subject areas). As shown in Table 9, participants teaching social studies reported to be the most frequent online seekers for technology-related information ($M = 2.73$, $SD = 1.00$). The second most frequent seekers of technology knowledge were math teachers ($M = 2.00$, $SD = 0.80$). English teachers reported searching online information less frequently for technology knowledge ($M = 1.95$, $SD = 0.72$) and science teachers reported to seek technology information the least ($M = 1.70$, $SD = 0.73$). This result means social studies teachers go online to find technology information almost about once or twice in a week whereas science teachers' seeking out happens less than once or twice in a month.

Table 9: Online Search for TK by Subject Area

Teaching Subject	*n*	*M* [a]	*SD*
Social studies	17	2.73	1.00
Math	14	2.00	0.80
English	20	1.95	0.72
Science	19	1.70	0.73

Note. [a]5-point scale from 1 (*never*) to 5 (*daily or more often*)

Overall, the analysis indicated that teachers were seeking information that reflected TK about once or twice a month. The descriptive analysis showed District B teachers were more likely to search for TK information than District A teachers. However, t-test result found no significant differences among teachers in the two districts. Middle school teachers were reported to be the most frequent information seekers among elementary and high school teachers, but ANOVA analysis on the differences were not statistical significant. Social studies teachers reported searching for TK information online more than other three teacher groups (i.e., math, science, and English).

Technological content knowledge (TCK). When teachers search for subject area/content technologies, they look, for example, for primary source apps for history class, a rollercoaster simulation for physics class, audio/video recordings of Hamlet performances for English class, or digital storytelling apps for English Language Arts. However, if online information search does not involve technologies that digitally communicate, teach, or represent subject area content for instructional or learning

purposes, it would not qualify for online search for subject area technologies. For example, an online search for a writing prompt handout that will be printed and distributed on paper to students or researching information about the role of United Nations during WWII to help build a class lecture are not information searches that would yield the development of TCK because the results do not yield a technology-content interaction. Among 285 survey respondents who completed initial TK section, 240 of them finished answering TCK section of the survey. The respondents from Districts A and B reported searching for information about content-specific technologies approximately once or twice a week (M = 2.81, SD = 1.07).

By district. Broken down into the district level, it was found that teachers in District A reported searching content-specific technology information online less (M = 2.76, SD = 1.04) compared to the counterpart in District B (M = 3.02, SD = 1.16) (see Table 10).

Table 10: Online Search for TCK by District

District	*n*	*M* [a]	*SD*
A	197	2.76	1.04
B	43	3.02	1.16

Note. [a]5-point scale from 1 (*never*) to 5 (*daily or more often*)

An assumption of normal distribution for t-test was assessed before running t-test analysis. The data was normally distributed for both Districts A and B, and thus an independent t-test for the two districts was conducted. The t-test using the pooled

standard error did not show significant statistical difference, $t(238) = -1.40$, $p = .163$. This means although District B teachers seem to search for technology content knowledge more than District A teachers, they are not statistically different.

By school level. The teachers' frequency of searching for TCK was compared by three school levels—elementary, middle, and high schools. Middle school teachers were reported to be the most frequent online seekers for content-specific technology information ($M = 2.89$, $SD = 1.19$) (see Table 11). Teachers in elementary school also reported similar but slightly less frequency score than middle school teachers ($M = 2.86$, $SD = 1.10$). High school teachers were found to be the least frequent online information seekers of technological content knowledge ($M = 2.68$, $SD = 0.98$).

Table 11: Online Search for TCK by School Level

School level	*n*	*M* [a]	*SD*
Elementary	74	2.86	1.10
Middle	32	2.89	1.19
High	66	2.68	0.98

Note. [a]5-point scale from 1 (*never*) to 5 (*daily or more often*)

The three groups mean scores were tested for statistical significance, using one-way ANOVA. As the assumptions of normal distribution and equal variance were met, the researcher proceeded to conduct ANOVA test. The ANOVA results indicated no meaningful difference in the frequency of the elementary, middle, and high school teachers, $F(2,169) = .62$, $p = .538$.

By subject area. The four subject areas most taught by participating teachers included English, science, social studies, and mathematics, respectively. A descriptive analysis was conducted to compare mean scores of frequency for searching TCK information online among the English, science, social studies, and mathematics teachers in middle and high schools across Districts A and B. The results showed participants teaching social studies sought out content-specific technology information most frequently, reporting they do online search for the information once or twice in a week (M = 3.08, SD = 1.14) (see Table 12). The least frequent seekers was science teachers, who reported searching technology content knowledge online approximately once or twice in a month (M = 2.28, SD = 0.85). English teachers (M = 2.70, SD = 0.99) and mathematics teachers (M = 2.62, SD = 0.87) showed similar frequency in online search for technological content knowledge. Both groups of teachers reported using online for the information search approximately three times in a month.

Table 12: Online Search for TCK by Subject Area

Teaching Subject	*n*	*M* [a]	*SD*
Social studies	17	3.08	1.14
English	20	2.70	0.99
Math	14	2.62	0.87
Science	19	2.28	0.85

Note. [a]5-point scale from 1 (*never*) to 5 (*daily or more often*)

From the analysis, it was found that District B teachers searched TCK-related information more than District A teachers and middle school teachers were more likely to

search TCK information online than teachers in elementary and high schools. However, none of the statistical analyses showed meaningful differences in information searching frequency between the two districts and at the three school levels. Social studies teachers indicated most active information-seeking behavior for content-specific technology knowledge online compared to that of math, English, and science teachers.

Technological pedagogical knowledge (TPK). Technological pedagogical knowledge (TPK) involves information about technology for general instruction. General instructional technologies include digital tools or ways of using tools to support general instruction and learning, such as for assessment, lectures, and presentations that are applicable equally well across different subject areas. For example, teachers may look for technological tools to help students organize concepts, find technologies to assist with student collaboration, or search for ways to use technologies to help with grading and assessment. Survey respondents in Districts A and B decreased from 240 who completed TCK section to 200 for TPK section. They reported searching technological pedagogical knowledge online less than once or twice in a month (M = 1.98, SD = 0.83).

By district. The comparison between Districts A and B showed teachers in District A less sought out information online about general instructional technologies (M = 1.90, SD = 0.69) (see Table 13). On the other hand, District B teachers reported searching for general instructional technologies more than once or twice in a moth (M = 2.33, SD = 1.21), which was more frequent than that of District A teachers.

Table 13: Online Search for TPK by District

District	*n*	*M* [a]	*SD*
A	163	1.90	0.69
B	37	2.33	1.21

Note. [a]5-point scale from 1 (*never*) to 5 (*daily or more often*)

Before testing the statistical difference between the Districts A and B teachers, a t-test assumption for normal distribution was assessed. As the data showed normal distribution, an independent sample t-test analysis was conducted to see statistical difference of the Districts A and B teachers' online search. The t-test results using unpooled standard error indicated a meaningful difference between the two districts, $t(42) = -2.08$, $p = .043$ (see Table 14).

Table 14: T-test of TPK Online Search Frequency for Districts A and B Teachers

	District A		District B			
Online Search	*M*	*SD*	*M*	*SD*	*t*	*df*
TPK	1.90	0.69	2.33	1.21	-2.08*	42

Note. * = $p < .05$.

By school level. Teachers in elementary, middle, and high schools across Districts A and B showed different frequencies for searching technological pedagogical knowledge (TPK) online although the gap among the three groups was not big. Elementary school teachers reported to be the most frequent seekers of general

instructional technology information (*M* = 2.04, *SD* = 0.88) (see Table 15), going online approximately once or twice per month for the information search. Middle school teachers reported searching online information for technological pedagogical knowledge (*M* = 1.89, *SD* = 0.87) slightly more than high school teachers (*M* = 1.85, *SD* = 0.70). Both middle and high school teachers indicated they look for the information online less than once or twice in a month.

Table 15: Online Search for TPK by School Level

School level	*n*	*M* [a]	*SD*
Elementary	74	2.04	0.88
Middle	32	1.89	0.87
High	66	1.85	0.70

Note. [a]5-point scale from 1 (*never*) to 5 (*daily or more often*)

For statistical significance, one-way ANOVA was performed with school level—elementary, middle, and high school teacher groups—as an independent variable and mean score of TPK search frequency as a dependent variable. When assumptions for ANOVA were assessed, the data was normally distributed and each group showed equal variance. As all assumptions were satisfied, one-way ANOVA test was performed. The results of the ANOVA found no meaningful difference among the three groups, $F(2, 169) = .96$, $p = .385$.

By subject area. Teachers from four subject areas—English or English Language Arts, science, social studies and mathematics—indicated frequency of searching for general instructional technology information online at a varying level. Social studies

teachers (n = 17) were found to be the most frequent seekers of TPK as they reported going online and searching TPK information more than once or twice in a month (M = 2.41, SD = 0.97) (see Table 16). English teachers (n = 20) and math teachers (n = 14) showed similar patterns, searching for general instructional technology less than once or twice in a month ($M_{English}$ = 1.93, $SD_{English}$ = 0.96; M_{math} = 1.90, SD_{math} = 1.05). The least frequent seekers of TPK were reported to be science teachers (n = 19, M = 1.50, SD = 0.89).

Table 16: Online Search for TPK by Subject Area

Teaching Subject	*n*	*M* [a]	*SD*
Social studies	17	2.41	0.97
English	20	1.93	0.96
Math	14	1.90	1.05
Science	19	1.50	0.89

Note. [a]5-point scale from 1 (*never*) to 5 (*daily or more often*)

In general, similar to TK and TCK online information search, teachers in District B reported seeking TPK information more than teachers in District A, with statistical difference in searching frequency. Although there was no statistical significance found, elementary teachers reported searching more for knowledge about general instructional technology than teachers in middle and high schools. Social studies teachers indicated that they were more likely to seek out TPK than other participants teaching math, science, and English.

Potential explanations for differences in teacher online searching by district. In the survey, teachers in District B indicated more frequent information searching online

than teachers in District A. Although it was not statistically significant, District B teachers reported visiting online resources more often than District A teachers, searching for information about technological know-how (TK) and content-specific technology (TCK). Regarding information searching on general instructional technology (TPK), t-test on search frequency of Districts A and B teachers showed statistically significant difference between the two groups, indicating District B teachers tended to look for TPK information more often than District A teachers. Interviews with teachers in the two districts revealed possible explanations on why District A teachers searched online information less than their counterpart in District B.

Ed Tech department. In the interviews, six out of 11 teachers in District A mentioned the support provided by the educational technology (Ed Tech) department housed in on their campus helped the District A teachers, so they were less likely to go online searching for information. The interview participants described the help from their in-house Ed Tech department the following four ways: individualized support, sharing resources, trying out new things, and general on-campus training. Most mentioned by District A teachers was individualized support that Ed Tech specialists offered. As the Ed Tech specialists provided supports tailored to individual teachers' needs, the District A teachers rarely went online searching for information. Mia, an elementary teacher, described "I don't know if I ever seek that out on the Internet. We have technology specialists on our campus." And she continued with her example:

> We have a spelling program called *Words Their Way* and it's all paper. It's like cutting and pasting. I said there's got to be a way to do this electronically. So she [Ed Tech specialist] helped me. We talked about some apps we could use. We got together with a first grade teacher who is doing the same thing, and we figured out a way to do it electronically. So I go to a person to ask those questions usually.

Liam, a middle school social science teacher in District A, also indicated how he sought help from an Ed Tech specialist on campus and it saved his time. As the on-campus Ed Tech specialist was "pretty high level" at technology itself and integrating it to instruction, Liam frequently asked him when he was looking for some learning tools or wanted to learn how to use certain tools. He remarked, "If I need to learn some simple tools, I go "hey I'm looking for some tools to use" [and] ask him instead of spending four hours trying to find it and then figuring out." He elaborated how the Ed Tech specialist would support teachers when new technologies are introduced, "He [Ed Tech specialist] will help them figure it out or he would help me. If I have a specific problem, help me solve that problem."

Iris, a middle school English teacher in District A, mentioned the individual supports that were tailored to each teacher's technology skill level. She said "So the Ed Techs are very good at helping no matter how much experience or how little experience you have. They're really great. And if they don't know the answer, they're quick to figure it out and share." She also added how the Ed Tech provides help during their professional learning community (PLC) meeting, "When we're brainstorming, he'll come into the meeting. So, that's awesome. Or if we're having problems with one program then we'll

call him he'll come meet with us and show us ‘OK well here's an alternative you can use.’ So it's pretty great.”

Wyatt who teaches social science in a high school in District A gave an example of how the Ed Tech on his campus provided individualized help when he was preparing for a project:

> When we did the project for World War I, I sat down with the Ed Tech and we talked about like: ‘what were the goals,’ ‘what is it that I wanted the kids to know’ and she helped provide some ideas and like: ‘oh here's an app that you could definitely use for this,’ ‘This is something to consider.’ And so yeah I found that very helpful.

Jeremy, a District A teacher in an elementary school, also mentioned similar support from an Ed Tech on his school campus, emphasizing the importance of having tailored support, “She will come to each team. We have different break times. So she will come and tell us about something she finds. Of course, something that's great for fourth or fifth grade might be useless for kindergarten. Waste the time if it is not something that's needed for everyone.”

New resources shared by Ed Techs seemed to be another reason why District A teachers reported searching information less frequently. Jeremy described how the Ed Tech specialist in his campus shares technological tools and technology-based classroom practices:

> She will come and give lessons to teams and teachers on how to use a program or an app or websites something that is good for technology. She shares different technological pieces that she finds. She keeps a blog showcasing what's done in the classroom. So really kind of emphasizes and focuses on that so that we don't have to go out and search for all this different types of technologies. She will do that. She will come in and introduce us to them and tells how to use.

The in-house Ed Tech specialist also provided help to District A teachers by trying new things out. Wyatt found the Ed Tech specialist "very helpful." He described the specialist on his campus as "always trying to develop new ways to use technology in the classroom" and "always available as a resource." He felt well supported by having the Ed Tech specialist, "it is a resource that the school provides that I had never seen before which is really, really helpful." Iris also made a similar comment saying, "Our Ed techs are awesome. They are all the time finding new programs and they tell us a lot."

In addition, the interviewees in District A mentioned that general training sessions prepared by the Ed Tech specialist have been helpful. Liam described what the Ed Tech specialist on his campus does, "He would provide us training specific training or district might say 'we're all going to do this' so everybody has to learn how to use like Google Classroom. So he would be more the people that are trying to help us how to do that." He continued to explain more about the on-campus training, which were held "at least once a month" as a form of "short sessions." He added, "you might go in the 30-minute session to learn something specific and then maybe every two or three months it might be like a half day training."

Different from District A, there was no Ed Tech specialist available on campus in District B schools. For District B teachers, IT specialists in district central office were the only way they could get help in regard to technical troubleshooting and integrating technology. Although Kate, an elementary teacher in District B, remarked positively about their IT department, saying the IT specialists come in "pretty quickly" and "really supportive," Frank, another elementary teacher in District B expressed disappointment, "we're not very tech savvy. Sometimes we forget and then we have to call them to help us and sometimes it takes a while. Technicians [IT specialists] are always busy. Or you have to put a special order for them to come and help you." It was obvious, from interviews with teachers in Districts A and B, that there is a big contrast in the coverage and depth of support available to teachers in both districts.

Available learning opportunities. Interviews with District A teachers also revealed that another possibility explaining District A teachers' less frequent online information seeking than District B teachers was the diverse learning opportunities available to teachers in District A.

Professional Learning Community (PLC) on campus. In schools in District A, PLC meetings were common as it was strongly recommended and supported by the district. In fact, many of District A teachers mentioned the positive impact of having PLCs among teachers in the same grade level or same subject areas. They mentioned they got helped from other teachers during the PLC time by sharing information, practices, and troubleshooting experiences. Liam, a social studies teacher in District A, gave a comprehensive description on his PLC:

> We meet four days a week. [In the PLC] you get to discuss or share ideas on how you can use technology for lesson. [What] if you're using technology and figured that's not your thing? You are really good at a lot of stuff, but that's just not your thing. So maybe I can help them do that and they can help me with whatever they're good at. There are a part of that they have expertise in. And then we have three in our [PLC]. So every brings something on the table. At any point, we might have a technology meeting and go. Or in my troubleshoot, somebody might help me whatever. We can work on whatever we need pretty much.

And he contributed the success of PLC to district support, saying: "The district tells us to do something. They provide us the time so we can do that. We've made really good use of it I think. We have a really strong PLC." He continued explaining how PLC can be beneficial for teachers who are not familiar with technology for teaching and learning:

> It's a lot easier to get on the technology bus if you decide to get on the bus instead of somebody's trying to push you on the bus. I might want to get on there with my friends. But if the bus is with all strangers, I am not sure if I want to get on there. So, that's where PLCs help, too.

PD trainings provided by district. Teacher interviewees in District A pointed out how helpful PD trainings offered in the district were. Wyatt, who recently joined in a school in District A, explained he felt fortunate to have introductory PD sessions:

> Fortunately this school provides at least introductory required training. So when you receive a new technology as part of the pilot program you are required to go to training on how to use that technology. They're working on more follow up with that, but introductory is required. Then after that it's more of optional to go to intermediary or expert based things like that.

Iris, another teacher in District A, expressed how satisfied she was with the technology trainings covering from a beginner level. She said, “they do a lot of training. For the ones they do, they really pare it down and start at the beginning, which is nice.” Furthermore, she mentioned more training opportunities were available during summer and how District A was trying to help teachers integrate technology in classroom environments, making teachers think about “what does this look like in your classroom?” and “what does this look like with these students?”

The teachers’ description on PD sessions offered in District A made a strong contrast with that of District B teachers. Although District B provided professional development opportunities for their teachers, District B teachers were not fully satisfied with the coverage and how the content is delivered in the PD trainings. For example, Frank mentioned:

> It's like: ‘OK here it is. You want to use it? Then use it. It's up to you.’ So pretty much that's how I see it. Support with district with technology? They really don't tell as much about that. Like I said, they give us videos that we can use and stuff like that. But no, they've never told us of the app.”

PD in various formats throughout the year. District A teachers indicated the availability of PD offerings that vary in learning time and topics as Liam illustrated:

> We will have a little 30-minute 40-minute training on it. And then like once every nine weeks or so we have [PD]. Or maybe [once] a semester, a longer, a day or half a day [PD], where we'll go have different topics. And so usually you get a choice. They will give you three or four and you pick two. You go to those.

District A teachers also revealed that not only short PD sessions such as "lunch and learns" during the semester but also an annual PD opportunities were available in District A. Naomi, a teacher in District A, provided detailed explanation on the PD offerings in her district as follows:

> We have 'Lunch and Learn' like they'll take the lunch periods and they'll teach things based on what we say we need to know. They'll have you bring a lunch and they'll spend the lunch period and they'll teach you how to do something and you can walk out of the room you know with that skill or with something you make with it with them helping you. Which is great. Also, [the annual technology-focused training] is awesome and the training that they have is really good.

Support for teacher professional learning. The interview results revealed that District A teachers received supports for their professional learning by the district and the supports were not limited to PD session offerings but it extended to visiting to other schools and monetary support. Wyatt gave detailed information on how he was able to

learn by visiting other school campus implementing a technology initiative and by watching the teachers doing a lesson with technology:

> We toured several different schools here in the district where we went around and they showed us this is how X teacher is doing this. And so it was really helpful to see what other successful teachers are doing across the district. This was happening during the school and the school paid for it. So they'll pay for a substitute to come in and cover my classroom while I go in and I learn about how these things are.

In Liam's case, he was financially supported for conference registration and encouraged to attend the conferences. He said, "they send you to different trainings to do and so that helps a lot. I went to [a local conference] this year. That was fun. Yeah that was good."

Online Information Sources and Value

In addition to online information search by teachers, the top five online resources that teachers used most frequently and how they valued the resources were explored. It should be noted that, for online information sources and value ratings, teacher participants were provided definitions of each knowledge area (i.e., TK, TCK, and TPK) along with example qualified for the knowledge area. This is different from online information search frequency of the three knowledge areas where a certain number of question items were given in each area. Therefore, it is possible that, for example, a teacher reported to search information in TK area about two times a month but used web

search engine three times a week to seek out information relevant to technical know-how. This is because there were three questions asking for how often participants search TK information, but more examples were provided, in online source use frequency and value ratings, to help respondent understand what qualifies for search activities for each knowledge type. If a respondent used web search engine many times to seek out TK information that was not listed in the TK information search frequency section, the participant's frequency of using web search engine can be higher than that of TK information search activity.

Technological knowledge (TK). The survey results indicated that teacher participants reported using web search engine (e.g., Google, Bing) most frequently (M = 3.52, SD = 1.48), meaning they visited the web search engines two to three times per week to search for technology-related information (see Figure 2). YouTube was reported to be the second most visited online source for technological know-how (M = 2.72, SD = 1.27). Teachers indicated they used YouTube approximately every other week. Newspaper website, such as New York Times, Education Week, was ranked third most frequently used online source, which teacher participants reported visiting once or twice in a month (M = 2.15, SD = 1.36). Facebook (M = 1.98, SD = 1.52) and Pinterest (M = 1.97, SD = 1.29) were listed in the fourth and fifth, respectively. For both sources, the teachers responded to use them slightly less than once or twice in a month. Padlet and Quora were identified the two least used online resources (M_{Padlet} = 1.13, SD_{Padlet} = 0.50; M_{Quora} = 1.08, SD_{Quora} = 0.44) as the participants indicated they rarely used Padlet and Quora for technological know-how.

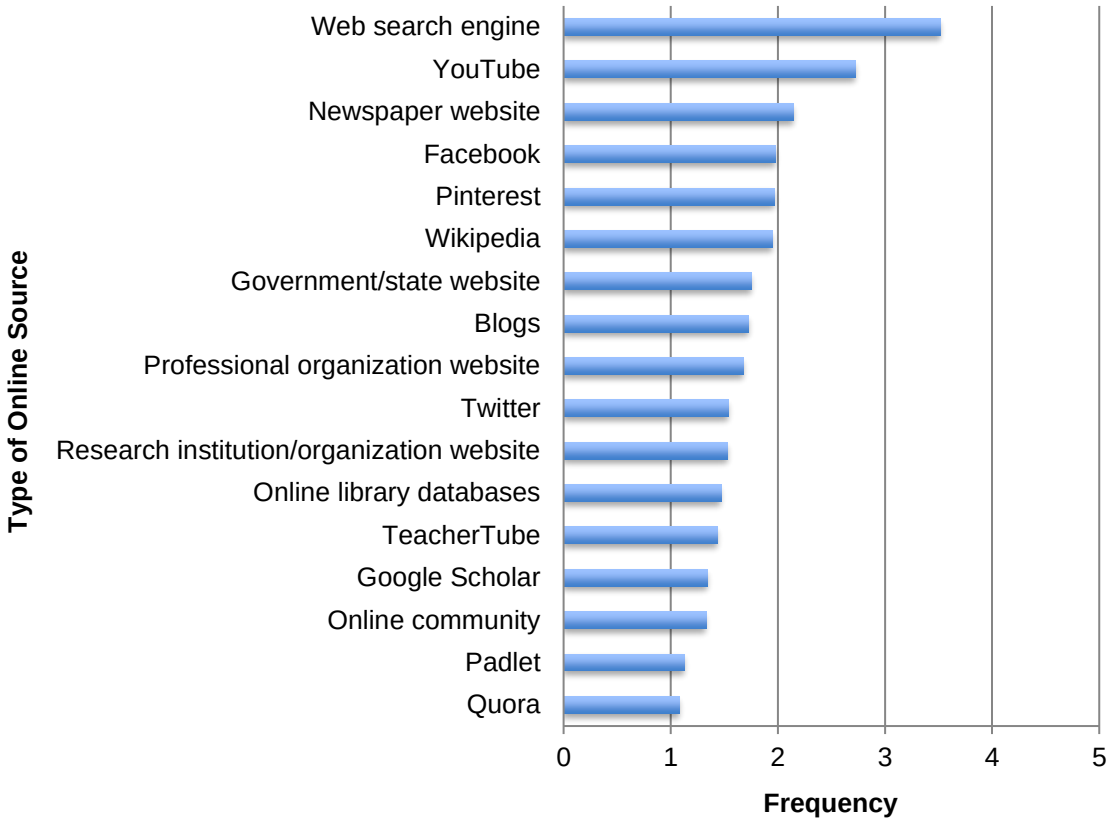

Figure 2: Online Sources and Frequency of Search (1 being *never* and 5 being *daily or more often*) for TK Information

The survey respondents were also asked to rate the value of each online resource they had used on a 5-point scale from 1 (*least valuable*) to 5 (*most valuable*). Web search engine, the most frequently used online source, was reported to be the most valuable resource for technology-related information search (n = 226, M = 3.90, SD = 1.00) (see Table 17). The teachers reported perceiving the web search engine is very valuable. The teacher participants also indicated they highly valued YouTube for searching

technological know-how (n = 205, M = 3.63, SD = 0.99). Online library databases such as EBSCO (n = 79, M = 3.41, SD = 1.03) and research institution/organization website including New Media Consortium and Pew Research Center (n = 80, M = 3.40, SD = 1.06) were rated similarly. The teachers indicated both resources were valuable for seeking out technological know-how. Google Scholar was used by fewer teachers (n = 49), but the users rated the resource valuable with mean score of 3.31 (SD = 1.08). Facebook and Padlet were the two resources that were least valued by the teacher respondents for technology-related information. Despite a considerable number of users (n = 85), Facebook was rated somewhat valuable (M = 2.38, SD = 1.14). As to Padlet, a small number of teachers had used it for searching technical knowledge (n = 22) and rated somewhat valuable (M = 2.36, SD = 1.14).

Table 17: Value of Online Sources for TK

Online Source	*n*	*M*[a]	*SD*
Web search engine (e.g., Google, Bing)	226	3.90	1.00
YouTube	205	3.63	0.99
Online library databases (e.g., EBSCO)	79	3.41	1.03
Research institution/organization website (e.g., New Media Consortium, Pew Research Center)	80	3.40	1.06
Google Scholar	49	3.31	1.08
Newspaper website (e.g., New York Times, Education Week)	132	3.22	1.08
TeacherTube	61	3.18	1.07
Government/state website (e.g., TEA, USDOE)	125	3.18	1.23
Professional organization website (e.g., NCTE, AAAS, TCEA, NCTM)	114	3.16	1.07
Pinterest	115	3.09	1.14
Online community (e.g., Edmodo, Ning)	45	3.02	0.94
Wikipedia	120	2.99	1.03
Blogs	101	2.96	0.96
Twitter	65	2.62	1.21
Quora	11	2.55	1.21
Facebook	85	2.38	1.14
Padlet	22	2.36	1.14

Note: [a]5-point scale from 1 (*least valuable*) to 5 (*most valuable*)

By district. Among 17 online resources, the five most frequently used ones were identified by Districts A and B teachers. They both reported using web search engine (e.g., Google, Bing) most often with mean score of 3.48 (*SD* = 1.47) and 3.76 (*SD* = 1.56), respectively (see Table 18). It means teachers in Districts A and B used the web search engine approximately two to three times in a week to find technological know-how. The survey participants also indicated to use YouTube the second most. YouTube was visited approximately once in every other week by District A teachers (*M* = 2.66, *SD*

= 1.22) and once or twice in a week by District B teachers (*M* = 3.02, *SD* = 1.46). However, the third most frequently used online resource was different among the two districts teachers. For District A teachers, it was newspaper website such as New York Times and Education Week (*M* = 2.13, *SD* = 1.35) whereas District B teachers used Pinterest (*M* = 2.59, *SD* = 1.50) for technology-related information search. The fourth and fifth ranked online resources were the same for both districts' teachers—Facebook and Wikipedia. Facebook was used less than once or twice in a month by District A teachers (*M* = 1.90, *SD* = 1.46) but more than once or twice in a month by District B teachers (*M* = 2.41, *SD* = 1.74). For Wikipedia, the result was similar to the case of Facebook. It was visited less than once or twice in a month by District A teachers (*M* = 1.88, *SD* = 1.09), but more than once or twice in a month by District B teachers (*M* = 2.30, *SD* = 1.32).

Table 18: Top Five Online Sources for TK by District

Online Source	*n*	*M* [a]	*SD*
District A			
Web search engine	222	3.48	1.47
YouTube	222	2.66	1.22
Newspaper website	221	2.13	1.35
Facebook	221	1.90	1.46
Wikipedia	222	1.88	1.09
District B			
Web search engine	42	3.76	1.56
YouTube	44	3.02	1.46
Pinterest	44	2.59	1.50
Facebook	44	2.41	1.74
Wikipedia	43	2.30	1.32

Note. [a]5-point scale from 1 (*never*) to 5 (*daily or more often*)

Figure 3 shows the top five online resources District A teachers reported using most frequently and its corresponding value they perceived. It was found that, in general, more used online sources for technological information were likely to be highly valued by the teachers in District A. Top 3 resources, including web search engine, YouTube, and newspaper website, were scored between valuable and very valuable with mean scores of 3.90 (n = 189, SD = 1.00), 3.59 (n = 172, SD = 0.97), and 3.17 (n = 109, SD = 1.07), respectively. Facebook was ranked fourth in use frequency, but was less valued by District A teachers (n = 66, M = 2.39, SD = 1.09) than fifth-ranked resource, Wikipedia. In contrast, Wikipedia was used in a similar frequency of Facebook, but its perceived value was higher than that of Facebook (n = 96, M = 2.92, SD = 0.96).

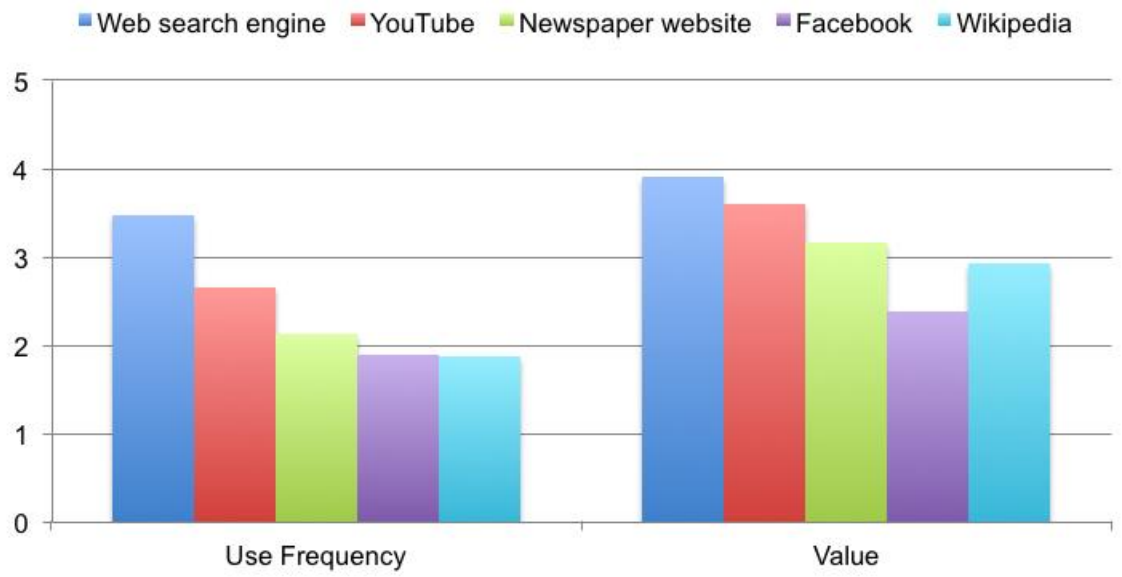

Figure 3: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TK Online Sources for District A Teachers

District B teachers showed a similar pattern of teachers in District A in reporting value of online sources for technological know-how (see Figure 4). Like District A teachers, teachers in District B indicated higher value for online resources they reported using often. Web search engine, YouTube, and Pinterest, which were the most frequently used resources, were rated from valuable to very valuable with mean scores of 3.92 (n = 37, SD = 1.04), 3.85 (n = 33, SD = 1.06), and 3.19 (n = 27, SD = 1.24), respectively. In spite of its frequent use, Facebook was perceived somewhat valuable (n = 19, M = 2.32, SD = 1.34) whereas Wikipedia was valued more (n = 24, M = 3.29, SD = 1.27) compared to its relatively less frequent use by District B teachers.

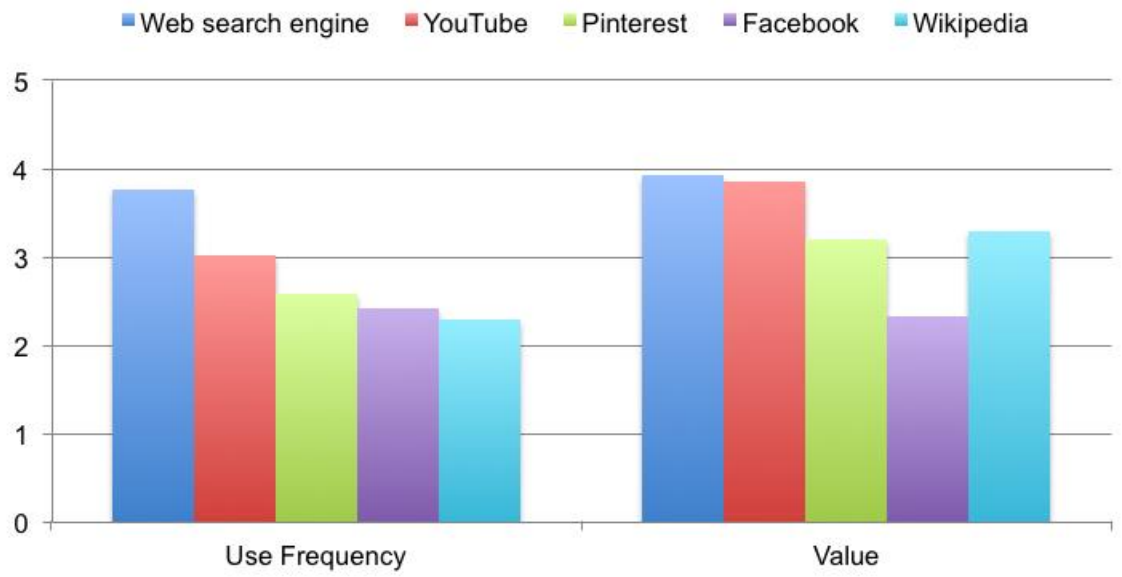

Figure 4: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TK Online Sources for District B Teachers

By school level. The top five online resources between elementary, middle, and high school teachers were compared to see which resources were most used and valued, and if there was any similar or different patterns among the teachers. The analysis revealed that, in searching for technological know-how information, all three groups of teachers reported using web search engine (e.g., Google, Bing) most frequently (M_{ES} = 3.47, SD_{ES} = 1.54; M_{MS} = 3.75, SD_{MS} = 1.55; M_{HS} = 3.30, SD_{HS} = 1.35), followed by YouTube (M_{ES} = 2.59, SD_{ES} = 1.30; M_{MS} = 2.75, SD_{MS} = 1.27; M_{HS} = 2.61, SD_{HS} = 1.19) (see Table 19). They all reported using web search engine more than once or twice in a week. YouTube was visited more than once or twice in a month by the teacher

participants. The third most used online resource for TK was different between the three teacher groups. Elementary school teachers visited Pinterest (M = 2.32, SD = 1.39) whereas middle school teachers used Facebook (M = 1.97, SD = 1.62). For high school teachers, newspaper website (e.g., New York Times, Education Week) was the third most popular online resource as they indicated using it more than once or twice in a week (M = 2.33, SD = 1.39). Wikipedia was found to be the fifth online resource both elementary and middle school teachers used with mean score of 1.92 (SD = 1.13) and 1.94 (SD = 1.32), respectively. However, Wikipedia was ranked fourth for high school teachers (M = 1.86, SD = 1.08). High school teachers also reported using Government/state website (e.g., TEA, USDOE) (M = 1.72, SD = 0.84), which was ranked fifth in frequently used online resources for technological information.

Table 19: Top Five Online Sources for TK by School Level

Online Source	*n*	*M* [a]	*SD*
Elementary School			
Web search engine	72	3.47	1.54
YouTube	74	2.59	1.30
Pinterest	74	2.32	1.39
Facebook	74	2.12	1.60
Wikipedia	74	1.92	1.13
Middle School			
Web search engine	32	3.75	1.55
YouTube	32	2.75	1.27
Facebook	32	1.97	1.62
Pinterest	30	1.97	1.16
Wikipedia	32	1.94	1.32
High School			
Web search engine	66	3.30	1.35
YouTube	66	2.61	1.19
Newspaper website	66	2.33	1.39
Wikipedia	66	1.86	1.08
Government/state website	65	1.72	0.84

Note. [a]5-point scale from 1 (*never*) to 5 (*daily or more often*)

When asked to indicate value of each online resource they have used, elementary and high teachers were likely to evaluate less valuable for resources they visited less frequently (see Figure 5). The teachers in elementary school perceived web search engine, YouTube, and Pinterest, which ranked first to third in use frequency, valuable to very valuable with mean scores of 3.91 (n = 67, SD = 1.06), 3.64 (n = 58, SD = 1.02), and 3.32 (n = 44, SD = 1.10), respectively. Although Wikipedia was ranked fifth in use frequency, it was rated close to valuable (n = 39, M = 2.95, SD = 1.06), which is higher score than fourth most visited resource, Facebook (n = 29, M = 2.55, SD = 1.09).

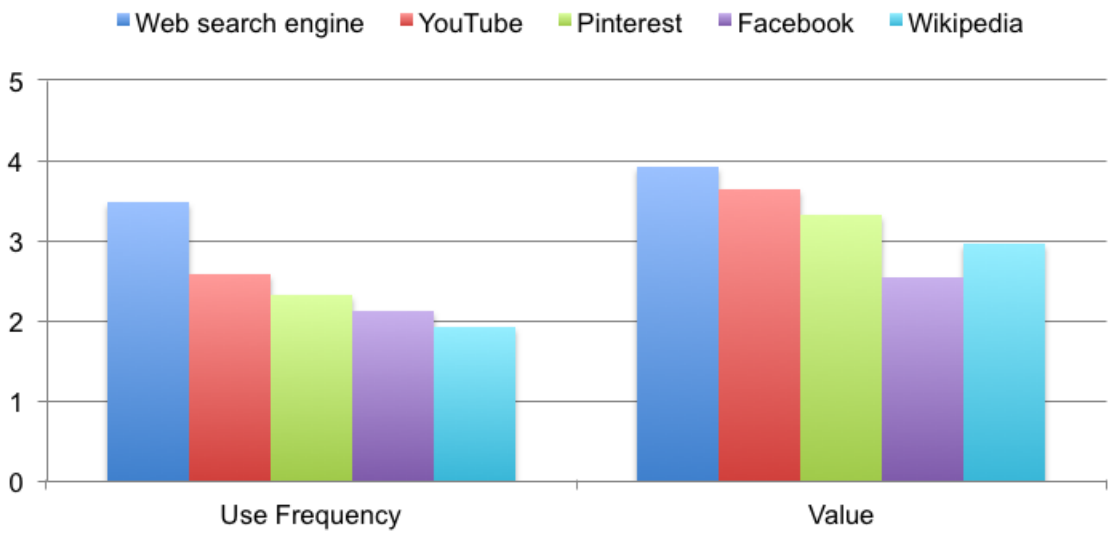

Figure 5: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TK Online Sources for Elementary School Teachers

For high school teachers, perceived value for top five online resources appeared in the same order of its corresponding use frequency (see Figure 6). Mean scores of top five most frequently visited online resources are ranged from 3.30 to 1.72 while the scores of its perceived value were from 3.79 to 2.94.

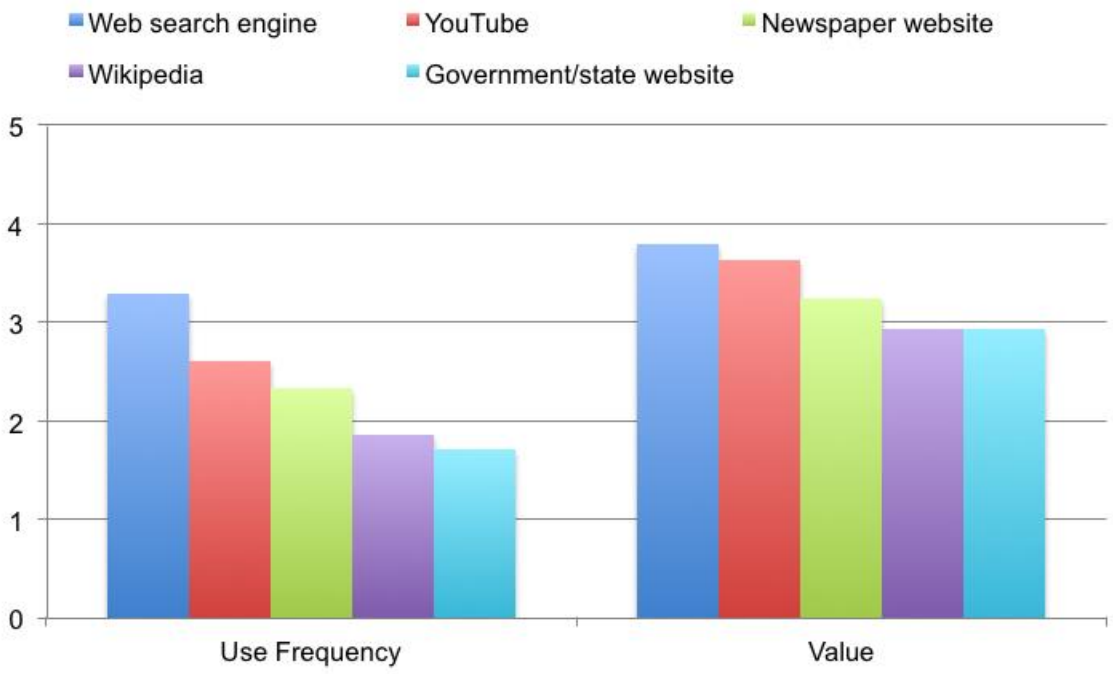

Figure 6: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TK Online Sources for High School Teachers

Teacher participants in middle school showed a distinct pattern compared to elementary and high school teachers. The value of each online resource did not follow the order of use frequency (see Figure 7). For the two most used online resources, web search engine and YouTube, both were rated valuable or close to valuable. Facebook and Pinterest tied in use frequency ($M_{\text{Facebook}} = 1.97$, $SD_{\text{Facebook}} = 1.62$; $M_{\text{Pinterest}} = 1.97$, $SD_{\text{Pinterest}} = 1.16$), but showed a large gap in perceived value with mean scores of 2.5 ($n = 10$, $SD = 1.27$) and 3.39 ($n = 18$, $SD = 1.04$), respectively. Wikipedia scored similarly

with Facebook in use frequency (M = 1.94, SD = 1.32) but valued higher than Facebook (n = 12, M = 3.25, SD = 1.14).

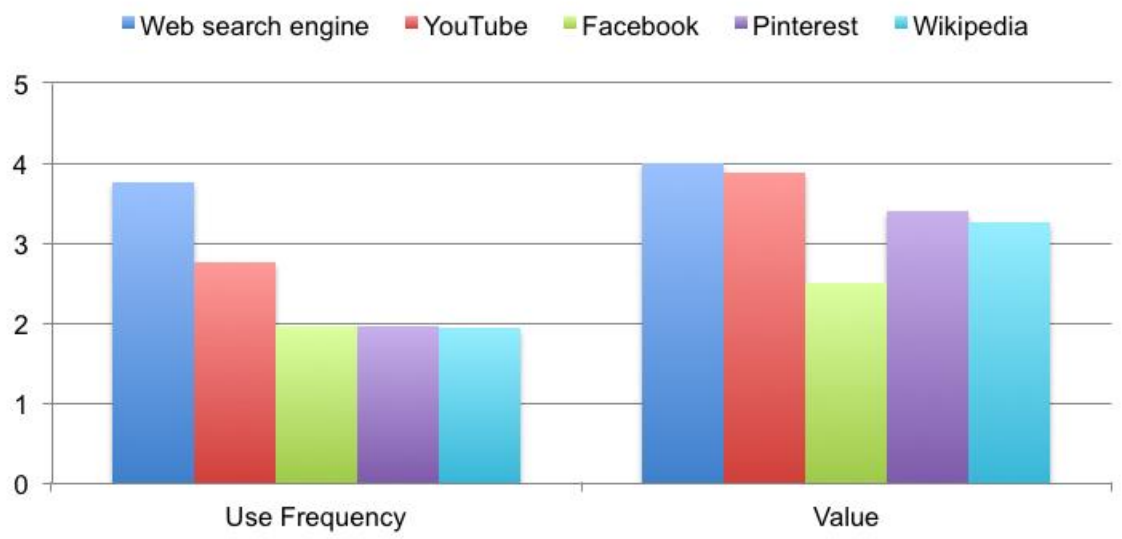

Figure 7: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TK Online Sources for Middle School Teachers

By subject area. Among math, science, social studies, and English teachers, the top five most popular online resources for technological information were explored. The teachers in the four different content areas all indicated they use web search engine most often (M_{math} = 3.93, SD_{math} = 1.44; $M_{science}$ = 2.68, $SD_{science}$ = 1.42; M_{ss} = 4.29, SD_{ss} = 1.16; $M_{English}$ = 3.40, $SD_{English}$ = 1.43) with second popular one being YouTube (M_{math} = 2.71, SD_{math} = 1.27; $M_{science}$ = 1.95, $SD_{science}$ = .91; M_{ss} = 3.53, SD_{ss} = 1.13; $M_{English}$ = 3.40, $SD_{English}$ = .82) (see Table 20). Whereas newspaper website was ranked third among math (M = 2.07, SD = 1.27), social studies (M = 3.53, SD = 1.46), and English teachers (M =

2.1, *SD* = 1.25), it was fourth most visited online resources for science teachers (*M* = 1.63, *SD* = 1.07). Wikipedia was ranked third by science teachers (*M* = 1.74, *SD* = 1.05), fourth by social studies teachers (*M* = 2.65, *SD* = 1.37), and fifth by math teachers (*M* = 1.79, *SD* = 0.98). However, it was not listed in the top five online resources that English teachers used often (*M* = 1.50, *SD* = 1.00). Facebook was also popular among the teacher participants for finding technological know-how. It was ranked fourth for math (*M* = 2.00, *SD* = 1.57), science (*M* = 1.63, *SD* = 1.38) (note that both newspaper website and Facebook are ranked in fourth for science teachers), and English teachers (*M* = 2.05, *SD* = 1.57). Social studies teachers reported often using research institution website (*M* = 2.47, *SD* = 1.23) and government/state website (*M* = 2.47, *SD* = 1.08), meaning they visited those online resources approximately once or twice in every other week. For English teachers, Twitter was ranked in fifth with mean score of 1.80 (*SD* = 1.44).

Table 20: Top Five Online Sources for TK by Subject Area

Online Source	*n*	*M* [a]	*SD*
Mathematics			
Web search engine	14	3.93	1.44
YouTube	14	2.71	1.27
Pinterest	14	2.07	1.27
Facebook	14	2.00	1.57
Wikipedia	14	1.79	0.98
Science			
Web search engine	19	2.68	1.42
YouTube	19	1.95	0.91
Facebook	19	1.74	1.05
Pinterest	19	1.63	1.07
Wikipedia	19	1.63	1.38
Social Studies			
Web search engine	17	4.29	1.16
YouTube	17	3.53	1.13
Newspaper website	17	3.53	1.46
Wikipedia	17	2.65	1.37
Research institution/organization website	17	2.47	1.23
Government/state website	17	2.47	1.01
English/English Language Arts			
Web search engine	20	3.40	1.43
YouTube	20	2.40	0.82
Newspaper website	20	2.10	1.25
Wikipedia	20	2.05	1.57
Government/state website	20	1.80	1.44

Note. [a]5-point scale from 1 (*never*) to 5 (*daily or more often*)

The value ratings for the online resources were compared by four subject areas—Mathematics, science, social studies, and English. Teachers in each content area indicated the perceived value of the online resources for seeking information about subject-specific technologies. For math teachers, the online resources they reported using frequently were

more likely to be evaluated in a positive way. For example, web search engine that was ranked first in use frequency showed the highest value ratings among the top five frequently used resources. The math teachers indicated web search engine is more than valuable with mean score of 3.67 (n = 12, SD = 0.89) (see Figure 8). A similar pattern appeared for YouTube, newspaper website, and Facebook which were ranked second to fourth in use frequency. YouTube was rated higher than newspaper website which was followed by Facebook in value ratings (n_{YouTube} = 12, M_{YouTube} = 3.42, SD_{YouTube} = 1.08; $n_{\text{newspaper}}$ = 8, $M_{\text{newspaper}}$ = 2.75, $SD_{\text{newspaper}}$ = 0.89; n_{Facebook} = 5, M_{Facebook} = 2.20, SD_{Facebook} = 1.30). Wikipedia was an exception in the pattern. It was ranked fifth in use frequency, but rated more valuable than third-ranked resource, newspaper website (n = 4, M = 3.00, SD = 1.29).

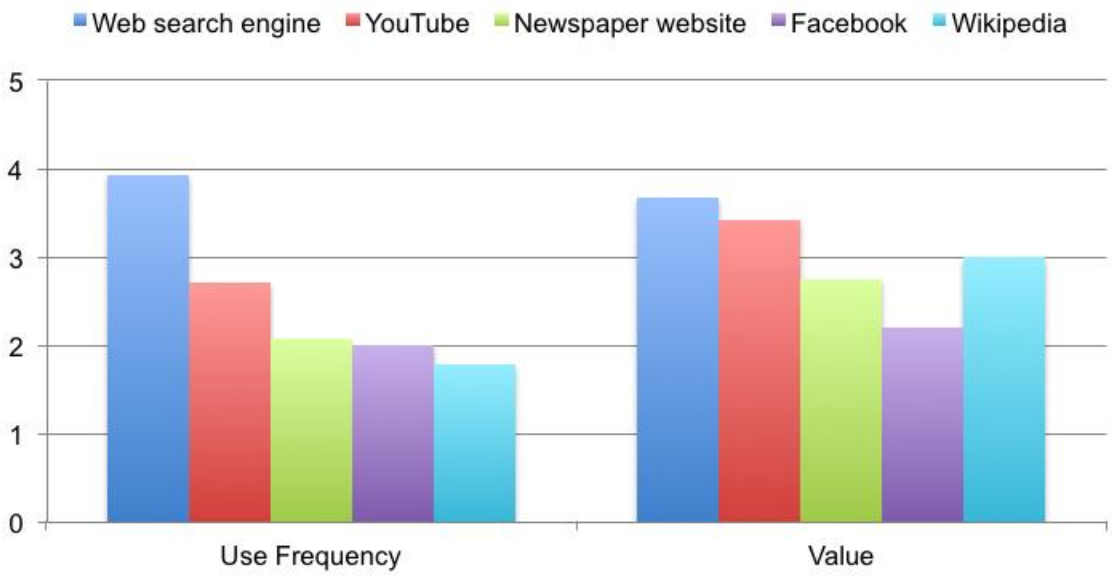

Figure 8: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TK Online Sources for Mathematics Teachers

In case of science teachers, value ratings of top five frequently used resources did not show a big difference between them. Although web search engine and newspaper website, which were ranked first and fourth in use frequency, were rated slightly higher than valuable with mean score of 3.38 (SD = 0.98) and 3.29 (SD = 0.95), respectively, the reset of three online resources, YouTube, Wikipedia, and Facebook, were also valuable to the science teachers (n_{YouTube} = 13, M_{YouTube} = 3.08, SD_{YouTube} = 1.04; $n_{\text{Wikipedia}}$ = 8, $M_{\text{Wikipedia}}$ = 3.13, $SD_{\text{Wikipedia}}$ = 1.13; n_{Facebook} = 4, M_{Facebook} = 3.00, SD_{Facebook} = 1.16) (see Figure 9).

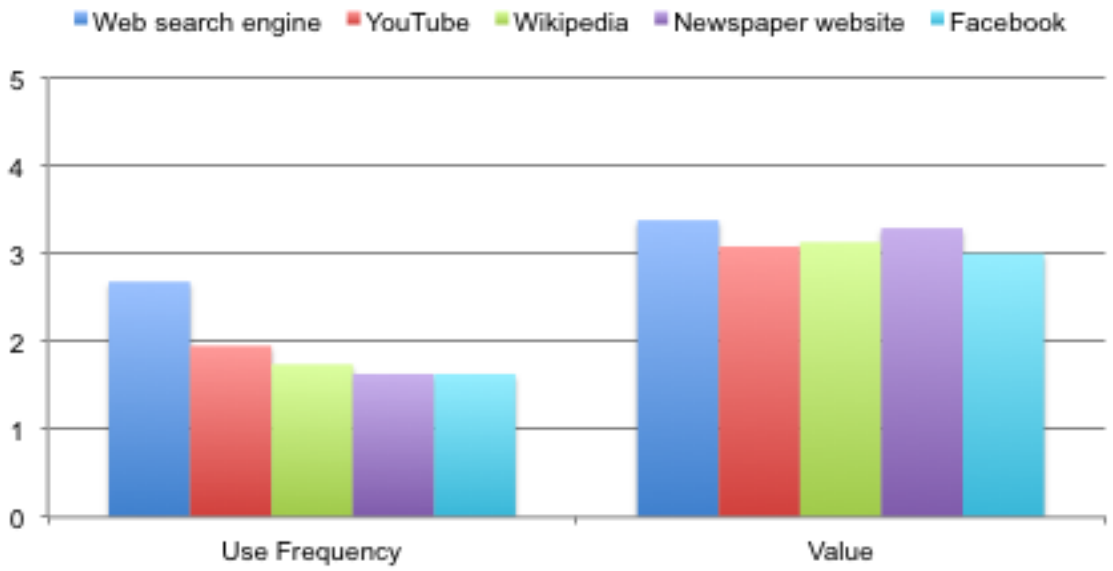

Figure 9: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TK Online Sources for Science Teachers

Social studies teachers, in general, gave higher value ratings for online resources they use often. The teachers indicated two online resources that were tied in second and fifth in use frequency. However, those tied resources were not tied in value ratings. One example is a case of YouTube and newspaper website. They were both second-most used online resources with mean score of 3.53, but YouTube was evaluated more valuable (M = 3.69, SD = 0.87) than newspaper (M = 3.44, SD = 0.81) by social studies teachers (see Figure 10). Another instance is a case of research institution website and government/state website. The social studies teachers reported using the two resources in

the same frequency (*M* = 2.47), but value rating of research institution website were higher (*M* = 3.08, *SD* = 0.95) than that of government/state website (*M* = 2.88, *SD* = 0.96).

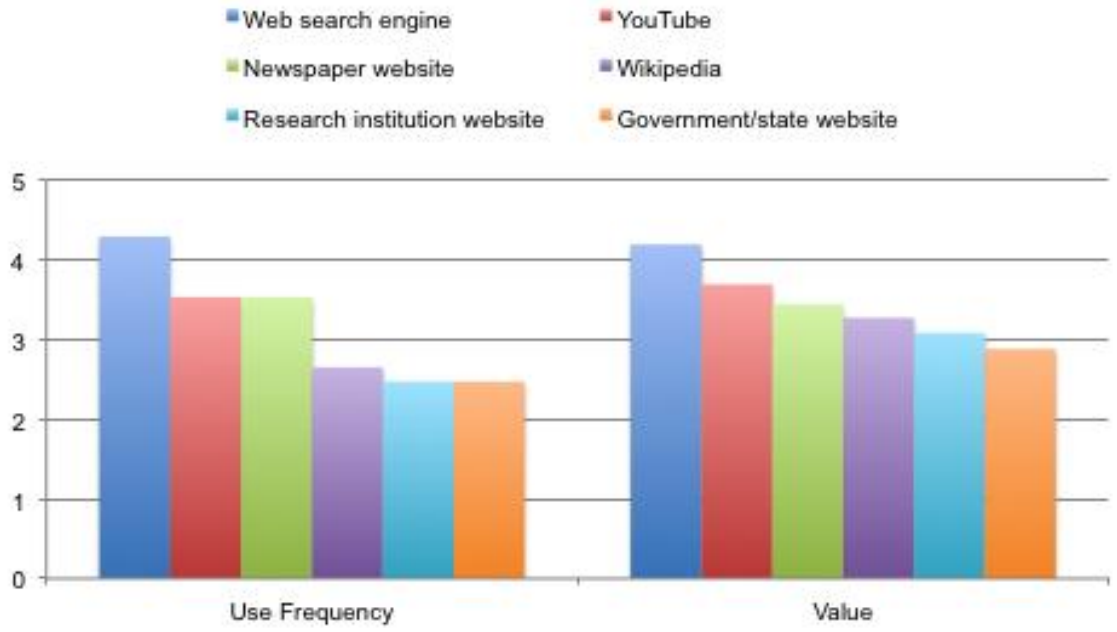

Figure 10: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TK Online Sources for Social Studies Teachers

Different from most of other teachers, the most used online resource did not get the highest values from English teachers. As shown in Figure 11, the most valued resource, among top five frequently used online resources, was YouTube (*M* = 3.83, *SD* = 0.62), which was ranked second in use frequency. For the resources ranked third to fifth in use frequency, including newspaper website, Facebook, and Twitter, was rated in the

order of its corresponding use frequency—more used online resources are likely to be valued highly.

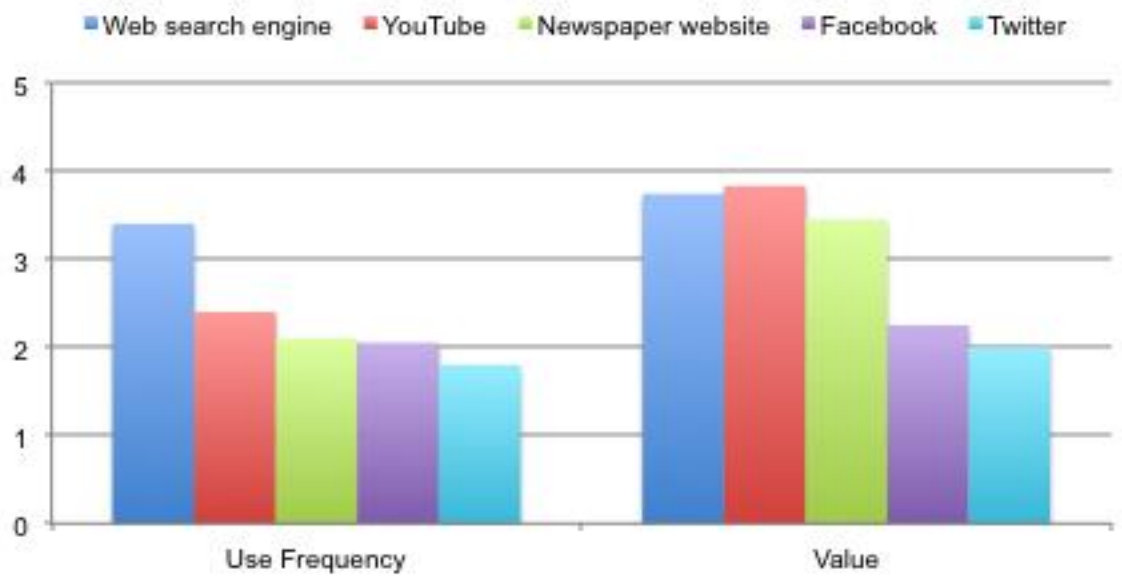

Figure 11: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TK Online Sources for English Teachers

The analysis revealed that web search engine was most used and valued online resource among teachers for TK information. When compared Districts A and B with top five resources, they shared four resources with web search engine being the most popular one for teachers in both districts, and in general, more used resources were more likely to be highly valued. The comparison among elementary, middle, and high schools also indicated web search engine is the most visited resources for TK, followed by YouTube, which was the same across school level. High school teachers tended to use newspaper

website, government/state website more than teachers in elementary and middle schools. Again, the overall pattern of value ratings was that the more frequently resources were used, the higher they were rated. Facebook tended to be valued less by elementary and middle school teachers. Regardless of subject areas of math, science, social studies, and English, teachers reported they went to web search engine most often for TK information searching and YouTube was always ranked the second. The use of web search engine was especially high among math and social studies teachers, indicating they went to web search engine three to four times a week. The two resources, web search engine and YouTube, were likely to be perceived as valuable or close to very valuable by teachers.

Technological content knowledge (TCK). Survey participants reported they use web search engine, such as Google and Bing, most frequently for seeking out TCK (*M* = 3.50, *SD* = 1.24) (see Figure 12). This means the teachers visit the web search engines more than twice in a week when they look for information about content-specific technologies. Next frequently used online source for the subject-specific technologies was YouTube with mean score of 2.69 (*SD* = 1.21). The teacher participants indicated they use YouTube approximately every other week for searching TCK. Another online resource they use more than twice in a month was found to be Pinterest (*M* = 2.10, *SD* = 1.30). Newspaper website (e.g., New York Times, Education Week) and Wikipedia ranked fourth and fifth frequently used resources by the teachers. The teachers reported using each resource about once in every other month with mean score of 1.95 (*SD* = 1.16) and 1.87 (*SD* = 1.15), respectively. As in TK, Quora and Padlet were the least frequently

used online resource for TCK (M_{Padlet} = 1.13, SD_{Padlet} = 0.53; M_{Quora} = 1.10, SD_{Quora} = 0.51).

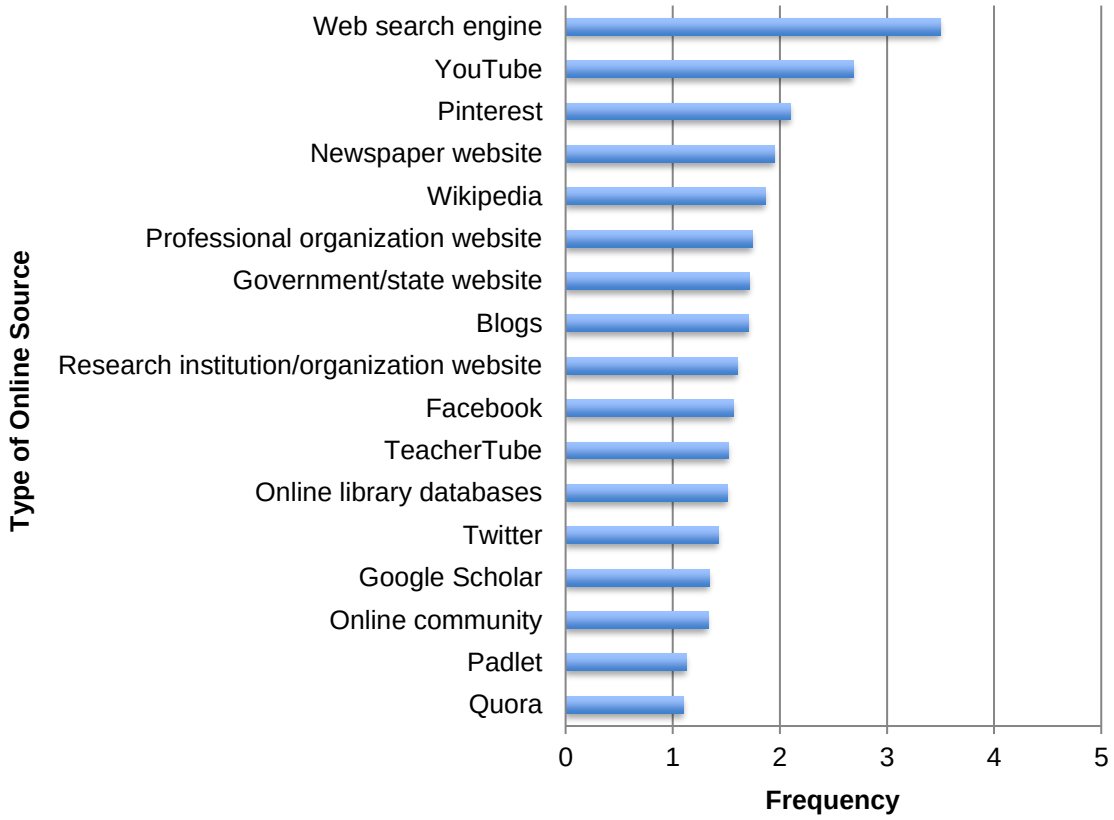

Figure 12: Online Sources and Frequency of Search (1 being *never* and 5 being *daily or more often*) for TCK Information

The survey respondents provided value ratings for each online resource they have used. They indicated web search engine is the most valuable online source for subject-specific technology information (n = 202, M = 3.83, SD = 1.4), rating it close to very valuable (see Table 21). It was followed by YouTube, which 176 teachers evaluated valuable with mean score of 3.45 (SD = 1.06). Pinterest was ranked third as 109 teachers

rated it as valuable (M = 3.39, SD = 1.04). Google Scholar and Twitter revealed similar number of users and value ratings. They both were rated valuable with mean score of 3.26 (n = 38, SD = 1.03) and 3.24 (n = 45, SD = 1.09), respectively. Quora and Padlet were found to be least valued online sources for TCK. The teacher participants rated the both resources somewhat valuable (n_{Quora} = 12, M_{Quora} = 2.75, SD_{Quora} = 1.29; n_{Padlet} = 18, M_{Padlet} = 2.28, SD_{Padlet} = 1.13).

Table 21: Value of Online Sources for TCK

Online Source	*n*	*M* [a]	*SD*
Web search engine (e.g., Google, Bing)	202	3.83	1.04
YouTube	176	3.45	1.06
Pinterest	109	3.39	1.04
Google Scholar	38	3.26	1.03
Twitter	45	3.24	1.09
Online library databases (e.g., EBSCO)	68	3.13	0.91
Newspaper website (e.g., New York Times, Education Week)	112	3.13	0.95
TeacherTube	56	3.11	0.97
Research institution/organization website (e.g., New Media Consortium, Pew Research Center)	72	3.10	0.95
Wikipedia	101	3.08	1.00
Blogs	90	3.08	0.94
Professional organization website (e.g., NCTE, AAAS, TCEA, NCTM)	99	3.07	0.98
Online community (e.g., Edmodo, Ning)	43	3.00	1.00
Government/state website (e.g., TEA, USDOE)	96	2.97	1.15
Facebook	57	2.91	1.15
Quora	12	2.75	1.29
Padlet	18	2.28	1.13

Note: [a]5-point scale from 1 (*least valuable*) to 5 (*most valuable*)

By district. Top five most frequently used online resources for TCK were shown to be the same among Districts A and B teachers. The teachers in the both districts used

web search engine the most for finding content-specific technology information ($M_{\text{Dist A}}$ = 3.48, $SD_{\text{Dist A}}$ = 1.22; $M_{\text{Dist B}}$ = 3.60, $SD_{\text{Dist B}}$ = 1.33) (see Table 22). In addition, it was revealed that online resources that were ranked second through fifth were the same for the teachers in the two different districts. For both districts teachers, YouTube was the second most frequently visited online resource with mean score of 2.65 (*SD* = 1.17) for District A teachers and 2.88 (*SD* = 1.37) for District B teachers, followed by Pinterest ($M_{\text{Dist A}}$ = 1.98, $SD_{\text{Dist A}}$ = 1.26; $M_{\text{Dist B}}$ = 2.62, $SD_{\text{Dist B}}$ = 1.32). Newspaper website ($M_{\text{Dist A}}$ = 1.90, $SD_{\text{Dist A}}$ = 1.09; $M_{\text{Dist B}}$ = 2.20, $SD_{\text{Dist B}}$ = 1.44) were placed in fourth and Wikipedia in fifth ($M_{\text{Dist A}}$ = 1.81, $SD_{\text{Dist A}}$ = 1.11; $M_{\text{Dist B}}$ = 2.15, $SD_{\text{Dist B}}$ = 1.30). For all top five resources, teachers in District B showed higher frequency of visiting the resources for seeking out TCK information.

Table 22: Top Five Online Sources for TCK by District

Online Source	*n*	*M* [a]	*SD*
District A			
Web search engine	184	3.48	1.22
YouTube	182	2.65	1.17
Pinterest	183	1.98	1.26
Newspaper website	181	1.90	1.09
Wikipedia	180	1.81	1.11
District B			
Web search engine	42	3.60	1.33
YouTube	42	2.88	1.37
Pinterest	42	2.62	1.32
Newspaper website	41	2.20	1.44
Wikipedia	41	2.15	1.30

Note. [a]5-point scale from 1 (*never*) to 5 (*daily or more often*)

Teachers in each district indicated the value of each online resource they have used. District A teachers perceived higher values for online resources they used more often (see Figure 13). The most frequently used resource, web search engine, was valued the most with mean score of 3.8 (n = 167, SD = 1.06), showing District A teachers' perceived value of the resource is close to *very valuable*. YouTube and Pinterest, which were second- and third-ranked in use frequency, were found to have similar values among teachers in District A (n_{YouTube} = 147, M_{YouTube} = 3.39, SD_{YouTube} = 1.07; $n_{\text{Pinterest}}$ = 82, $M_{\text{Pinterest}}$ = 3.33, $SD_{\text{Pinterest}}$ = 1.08). Newspaper website and Wikipedia were fourth- and fifth-frequently used resources with a small gap in mean score. Those two resources scored the same in value ratings ($n_{\text{newspaper}}$ = 92, $M_{\text{newspaper}}$ = 3.03, $SD_{\text{newspaper}}$ = 0.91; $n_{\text{Wikipedia}}$ = 78, $M_{\text{Wikipedia}}$ = 3.03, $SD_{\text{Wikipedia}}$ = 0.97).

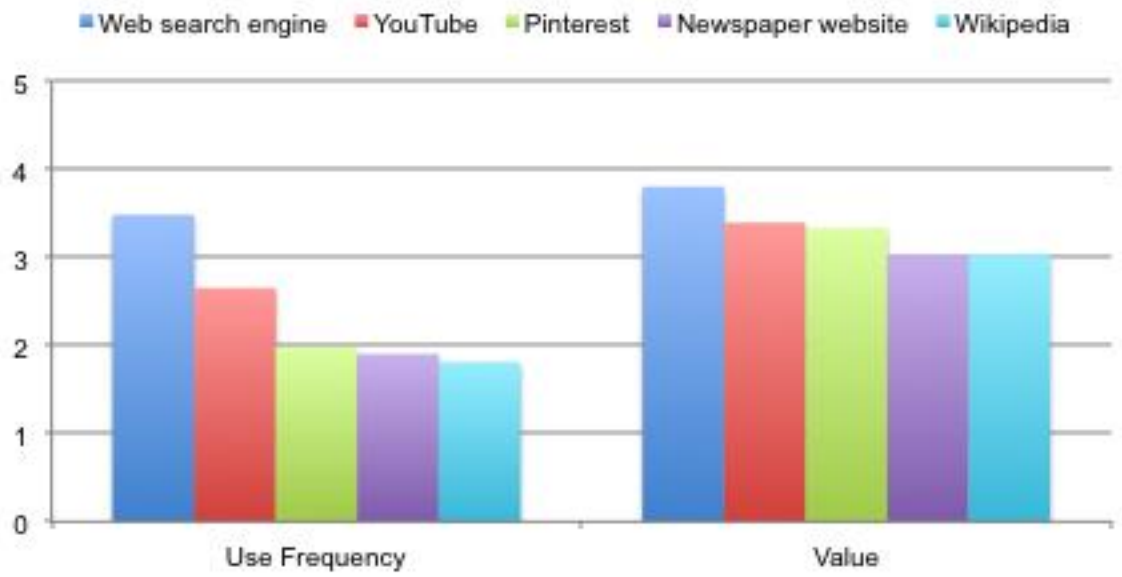

Figure 13: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TCK Online Sources for District A Teachers

Teachers in District B also indicated higher value ratings for online resources they are visiting often in searching for content-specific technological information (see Figure 14). When compared value ratings of the top five most frequently used resources, web search engine, the first-ranked resource in use frequency, were found to be most valuable with mean score of 3.97 (n = 35, SD = 0.92). This means that the District B teachers perceive web search engine *very valuable*. The second-valued online resource among the top five most frequently used ones was YouTube (n = 29, M = 3.72, SD = 1.00). Pinterest and newspaper website were ranked third and fourth in use frequency, but, in value ratings, they received similar ratings with mean score of 3.56 (n = 27, SD = 0.93) and

3.55 (n = 20, SD = 1.05), respectively. Overall, the District B teachers rated all online resources in the top five use frequency more than *valuable*.

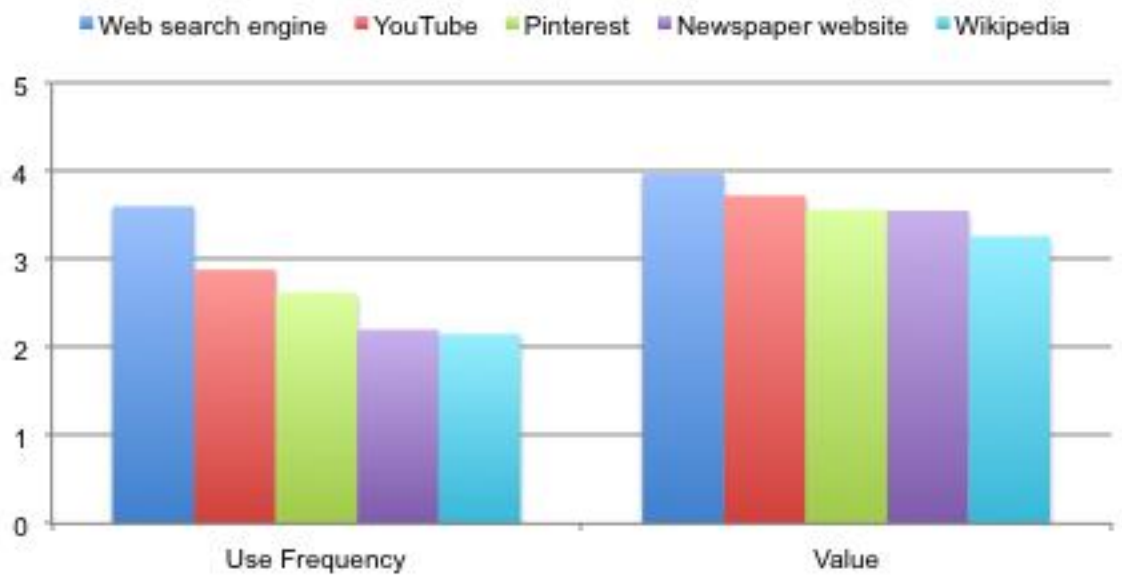

Figure 14: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TCK Online Sources for District B Teachers

By school level. The use frequency of online resources for seeking out TCK was compared by teachers in different school levels (i.e., elementary, middle, and high schools). For all three groups of teachers, the first two most frequently used resources were the same—web search engine and YouTube. For web search engine, the survey results revealed that elementary school teachers use the web search engine *(M* = 3.57, *SD* = 1.27) slightly more that middle school teachers *(M* = 3.53, *SD* = 1.22) (see Table 23). High school teachers were found to be the least users of web search engine (*M* = 3.30, *SD*

= 1.18). In all three groups, teachers indicated they use web search engine more than once or twice in a week for TCK information seeking. In case of YouTube, teachers in middle school reported most frequent use *(M* = 2.97, *SD* = 1.06) while elementary *(M* = 2.68, *SD* = 1.30) and high school teachers *(M* = 2.65, *SD* = 1.16) expressed similar use frequency. Pinterest ranked third for both elementary *(M* = 2.60, *SD* = 1.36) and middle school teachers *(M* = 2.22, *SD* = 1.26) but was not ranked in top five among high school teachers. In contrast, newspaper website ranked in the top five only among middle *(M* = 1.84, *SD* = 1.08) and high school teachers *(M* = 2.11, *SD* = 1.13), but not elementary school teachers. Wikipedia was included in the top five most frequently used resources for all three group teachers (M_{ES} = 1.85, SD_{ES} = 1.16; M_{MS} = 1.81, SD_{MS} = 1.15; M_{HS} = 1.94, SD_{HS} = 1.13), showing all teachers use it less than once or twice in a month. Blog appeared in the top five rank only among the elementary school teachers *(M* = 1.86, *SD* = 1.04) and professional organization website was included in the top five list only by high school teachers *(M* = 1.71, *SD* = 0.86).

Table 23: Top Five Online Sources for TCK by School Level

Online Source	*n*	*M* [a]	*SD*
Elementary School			
Web search engine	74	3.57	1.27
YouTube	72	2.68	1.30
Pinterest	73	2.60	1.36
Blogs	72	1.86	1.04
Wikipedia	72	1.85	1.16
Middle School			
Web search engine	32	3.53	1.22
YouTube	32	2.97	1.06
Pinterest	32	2.22	1.26
Newspaper website	32	1.84	1.08
Wikipedia	32	1.81	1.15
High School			
Web search engine	66	3.30	1.18
YouTube	66	2.65	1.16
Newspaper website	65	2.11	1.13
Wikipedia	65	1.94	1.13
Professional organization website	65	1.71	0.86

Note. [a]5-point scale from 1 (*never*) to 5 (*daily or more often*)

The value ratings of the top five online resources were analyzed to see how similar or different the rating scores among the three groups of teachers are. For elementary, middle, and high school teachers, the overall trends showed similar patterns—the more frequently used resources are more likely to be highly valued. The teacher groups have in common in that there is always one exception while following the overall trends. For teachers in elementary school, Pinterest, the third-ranked in use frequency, was an exception from the dominant pattern (see Figure 15). In value ratings, the elementary teachers reported Pinterest (n = 53, M = 3.49, SD = 1.12) is more valuable

than YouTube, a second-ranked resource (n = 59, M = 3.39, SD = 1.08). Overall, the elementary teachers value ratings for the five most frequently used resources were around *valuable* with the highest being 3.77 and the lowest being 2.89.

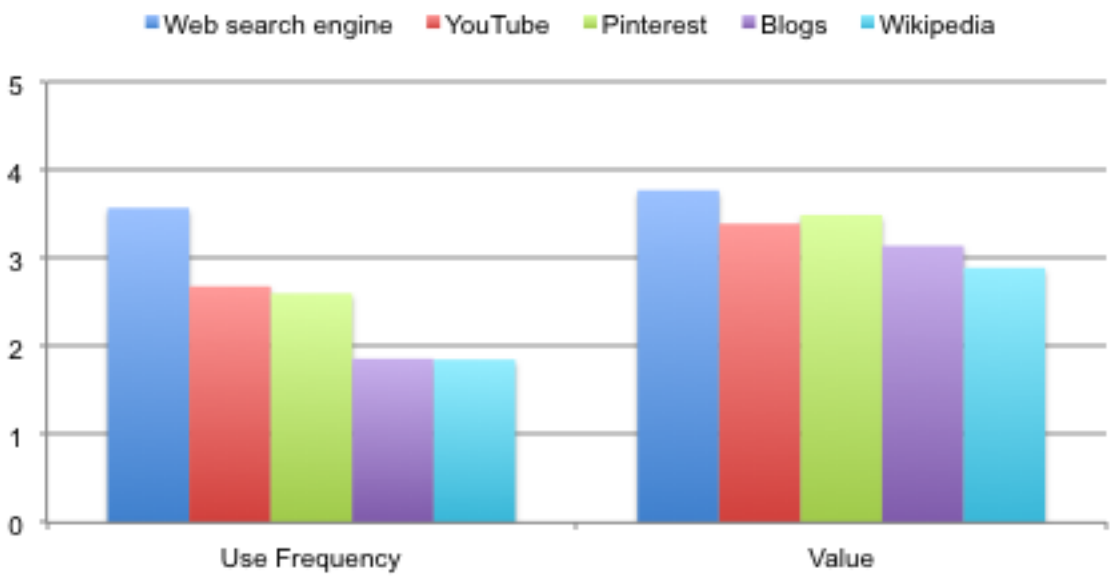

Figure 15: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TCK Online Sources for Elementary School Teachers

The high school teachers' ratings on TCK-related online resources revealed similar pattern as elementary school teachers (see Figure 16), showing higher values for more frequently used resources. Their value ratings for the top five resources ranged from 3.72 to 2.79, meaning they perceived the online resources *valuable* in general. The value rating of web search engine, the most frequently used resource, was the highest (n = 64, M = 3.72, SD = 1.05) while that of professional organization website, ranked fifth in use

frequency was the lowest (n = 33, M = 2.79, SD = 0.78). Wikipedia was found to have a slightly higher value rating (n = 34, M = 3.18, SD = 0.87) than newspaper website (n = 43, M = 3.16, SD = 0.92), showing a flipped rank from use frequency.

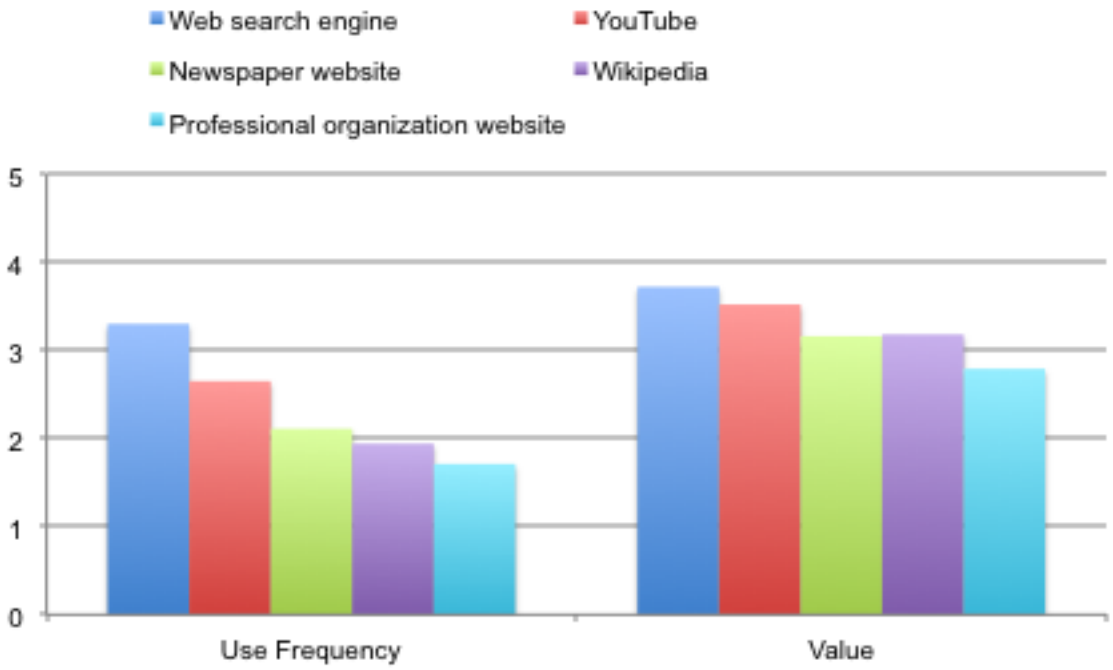

Figure 16: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TCK Online Sources for High School Teachers

The middle school teachers also showed an exception that does not follow the general trend in the value ratings (see Figure 17). All four out of the top five online resources were rated in the same order as they were ranked in use frequency. That is, the teachers in middle school perceived web search engine, first-ranked online resource in use frequency, most valuable (n = 30, M = 4.10, SD = 0.96) whereas newspaper website,

fourth-ranked in use frequency, were the least valuable (n = 18, M = 3.00, SD = 0.97) among the top five frequently used resources. The exception was Wikipedia. Wikipedia was ranked in fifth in use frequency with lower mean score than newspaper website, but, in value ratings, it was reported to be more valuable than newspaper website with mean scores of 3.43 (n = 14, SD = 1.02). One notable trend that differentiates middle school teacher group from elementary and high school teacher groups was higher value rating scores. The middle school teachers reported value ratings scores from 4.10 to 3.00, showing 0.33 and 0.38 point higher than the highest of elementary and high school teachers, respectively.

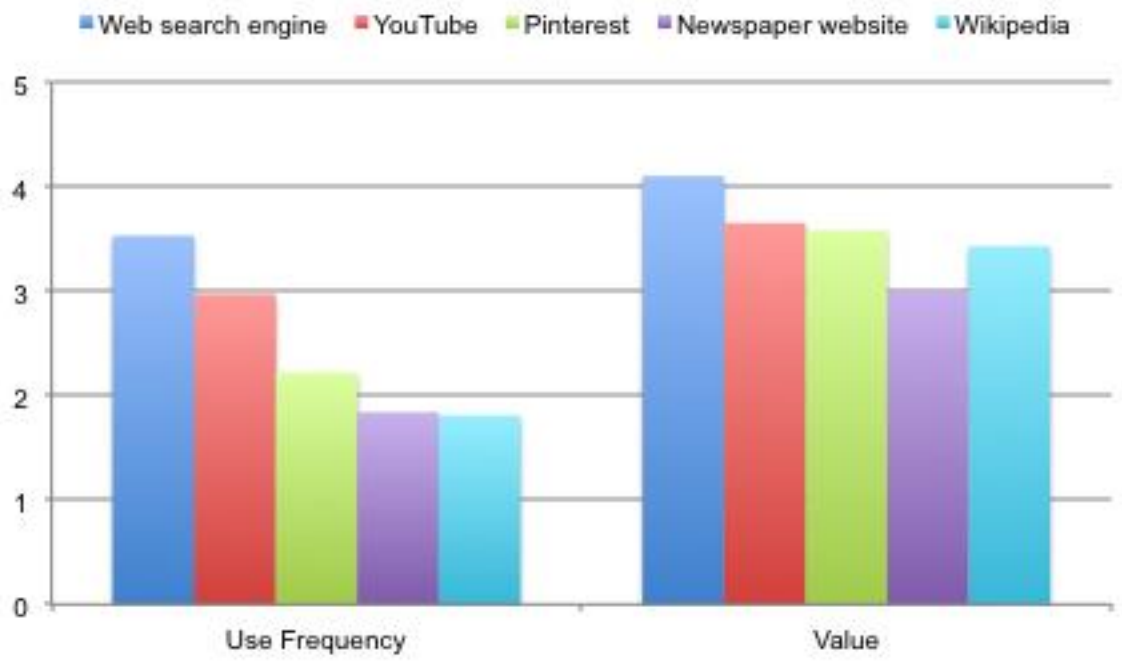

Figure 17: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TCK Online Sources for Middle School Teachers

By subject area. Survey responses from teachers of mathematics, science, social studies, and English were further explored. The top five online resources the four subject group teachers most frequently visited were compared among the teacher groups. The results indicated that first- and second-ranked resources were the same across the four groups, which were web search engine and YouTube, respectively (see Table 24). Regardless of their content area, all teachers reported they use web search engine most frequently for seeking out TCK information. Social studies teachers were the most avid user of web search engine with mean score of 4.18 (SD = 0.95), meaning they went on web search engine three to four times in a week. It was followed by English teachers (M = 3.35, SD = 0.99) who indicated visiting web search engine more than once or twice in a week. Math and science teachers, compared to social science and English teachers, were both less likely to use web search engine (M_{math} = 2.86, SD_{math} = 1.35; $M_{science}$ = 2.74, $SD_{science}$ = 0.87), which means they used web search engine approximately once or twice in every other week. For YouTube, social science teachers showed the most frequent visit (M = 3.12, SD = 0.93) than the rest of three teacher groups. They indicated using YouTube more than once or twice in a week. Although YouTube was ranked second, math, science, and English teachers' use was less than once or twice in a week (M_{math} = 2.36, SD_{math} = 1.39; $M_{science}$ = 2.21, $SD_{science}$ = 0.86; $M_{English}$ = 2.55, $SD_{English}$ = 0.89). Newspaper website were ranked in the top five resources among all four groups of teachers and Wikipedia was also ranked in the top five among all except English teachers.

There were instances where an online resource was ranked in the top five by a certain group of teachers. For example, professional organization website was third most visited one for math teachers (M = 1.79, SD = 1.12) and fourth for English teachers (M = 1.70, SD = 0.92). Pinterest was also listed in the top five only among science teachers (M = 1.53, SD = 0.70) and English teachers (M = 1.65, SD = 1.09). Government/state website was included in the top five ranks only by math teachers (M = 1.64, SD = 1.08) and research institution/organization website was made in the top five by social studies teacher group only (M = 2.35, SD = 1.37).

In general, social studies teachers showed more frequent pattern in using online resources than the rest of the three teachers groups. They indicated using all of the top five online resources more than once or twice in a month with highest being 4.18, meaning three to four times in a week, and lowest being 2.35, meaning more than once and twice in a month. Given that only first- and second-ranked resources scored higher than 2 in use frequency among math, science, and English teacher groups, social studies teachers can be regarded as very active users of online resources in searching for content-specific technological information.

Table 24: Top Five Online Sources for TCK by Subject Area

Online Source	*n*	*M* [a]	*SD*
Mathematics			
Web search engine	14	2.86	1.35
YouTube	14	2.36	1.39
Professional organization website	14	1.79	1.12
Wikipedia	13	1.77	1.30
Newspaper website	14	1.64	1.08
Government/state website	14	1.64	1.08
Science			
Web search engine	19	2.74	0.87
YouTube	19	2.21	0.86
Wikipedia	19	1.84	0.83
Newspaper website	18	1.78	1.00
Pinterest	19	1.53	0.70
Social Studies			
Web search engine	17	4.18	0.95
YouTube	17	3.12	0.93
Newspaper website	17	2.76	1.30
Wikipedia	17	2.41	1.28
Research institution/organization website	17	2.35	1.37
English/English Language Arts			
Web search engine	20	3.35	0.99
YouTube	20	2.55	0.89
Newspaper website	20	1.90	0.97
Professional organization website	20	1.70	0.92
Pinterest	20	1.65	1.09

Note. [a]5-point scale from 1 (*never*) to 5 (*daily or more often*)

The value rating scores evaluated by math teachers showed mixed results compared to its use frequency. The math teachers reported visiting YouTube less frequently than web search engine, but gave it a higher rating ($n_{YouTube}$ = 10, $M_{YouTube}$ = 3.40, $SD_{YouTube}$ = 1.17) than web search engine (n_{web} = 12, M_{web} = 3.17, SD_{web} = 1.12) (see Figure 18). The same pattern appeared for third- and fourth-ranked resources in use frequency—more frequently used resource was rated less valuable.

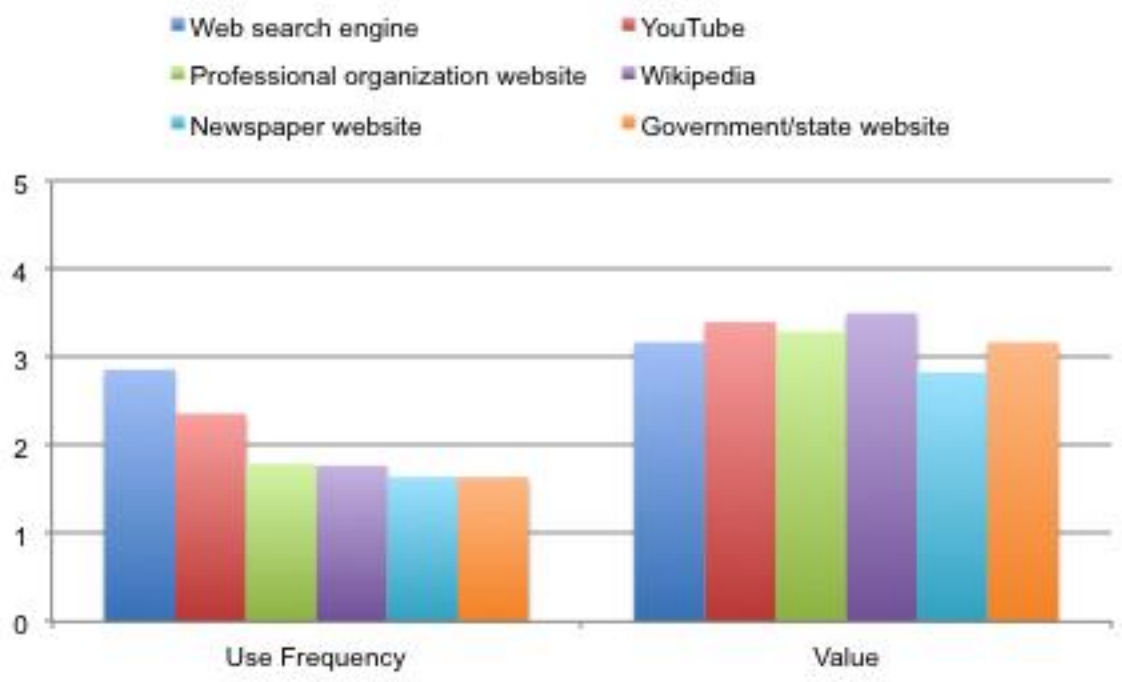

Figure 18: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TCK Online Sources for Mathematics Teachers

Science teacher group indicated less used resources were less valuable (see Figure 19). One exception was Pinterest which ranked fifth in use frequency. The value rating scores of Pinterest was higher than third-ranked resource Wikipedia with mean score of 3.13 (n = 8, SD = 0.99).

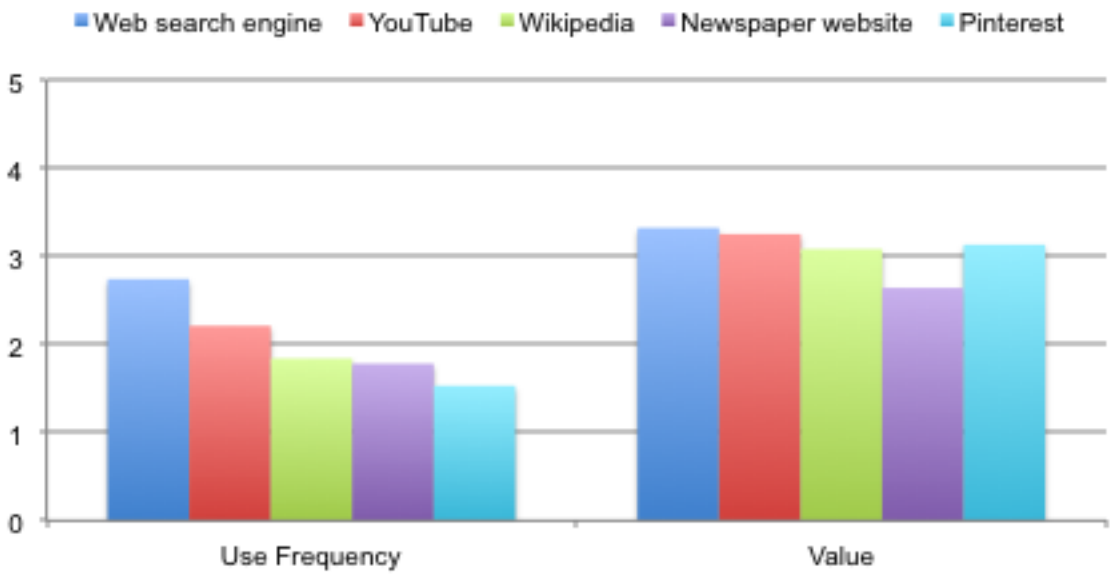

Figure 19: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TCK Online Sources for Science Teachers

The teacher participants teaching social studies revealed a similar pattern as in science teachers—less used resources are less valued (see Figure 20). One exception to this pattern was Wikipedia, which ranked fourth in use frequency but was rated higher (n = 10, M = 3.45, SD = 0.69), than third-most frequently visited resources (n = 14, M = 3.36, SD = 0.84) and scored close to that of second-ranked online resources (n = 17, M = 3.47, SD = 0.80).

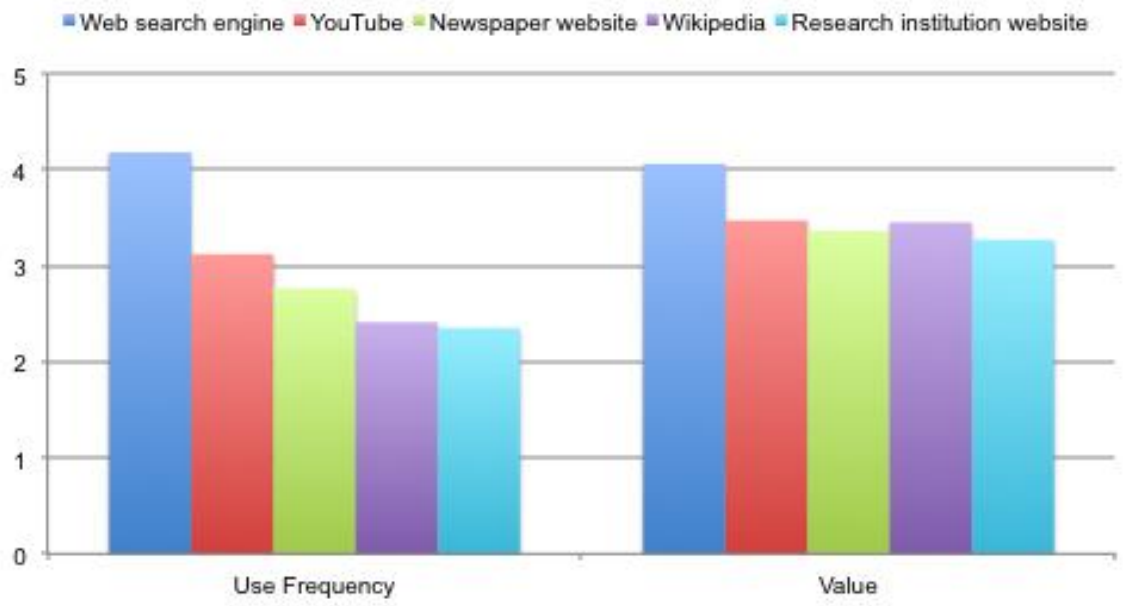

Figure 20: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TCK Online Sources for Social Studies Teachers

Among English teachers, the overall pattern was similar to other group of teachers. The general trend was that as a resource was less used, it was rated with less value (see Figure 21). However, although the difference is not big, Pinterest, the fifth-ranked in use frequency, was valued more with mean score of 3.17 (n = 6, SD = 0.98) than professional organization website (n = 11, M = 3.00, SD = 0.78), the fourth-ranked in use frequency.

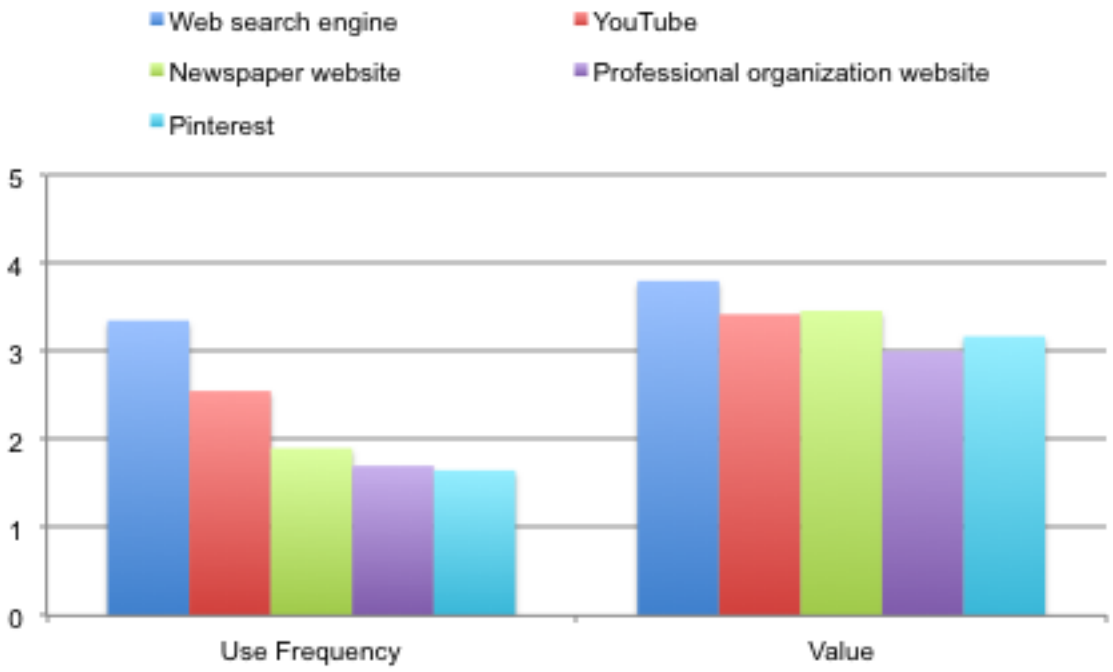

Figure 21: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TCK Online Sources for English Teachers

Similar to TK information searching, teachers used web search engine and YouTube the most for seeking out information that reflects TCK, with a pattern of giving

higher values for resources they frequently used. Teachers in District A and District B listed the top five most frequently using resources in the same order of web search engine, YouTube, Pinterest, newspaper website, and Wikipedia. In general, the value rating scores for the top five resources followed the order of use frequency. The three groups of elementary, middle, and high schools tended to have similar resources in their top five, which were web search engine, YouTube, and Wikipedia. As school grade goes higher, resources such as newspaper website and professional organization website were more likely to be used by teachers. Web search engine and YouTube were popular across teachers teaching different subjects (i.e., math, science, social science, and English). Social science teachers again showed very high frequency of visiting web search engine.

Technological pedagogical knowledge (TPK). For information on general instructional technology, teachers in the two districts used web search engines, such as Google and Bing, most frequently (M = 2.97, SD = 1.30) (see Figure 22). They reported going on to the web search engines approximately one or two times in a week. The second most used online source was found to be YouTube (M = 2.21, SD = 1.20). Teachers went to YouTube for technological pedagogical knowledge more than once or twice in a month. Pinterest was the third frequently used online source for teachers in searching information for instructional use of technology (M = 1.77, SD = 1.11), followed by newspaper website (e.g., New York Times, Education Week) (M = 1.68, SD = 1.06) and government/state website (e.g., TEA, USDOE) (M = 1.61, SD = 0.96). Although Pinterest, newspaper website, and government/state website are listed among the top five that teachers visit often, the frequency of using those resources are far less than the top

two resources. The survey revealed the least used online sources, Quora (*M* = 1.09, *SD* = 0.53) and Padlet (*M* = 1.11, *SD* = 0.57).

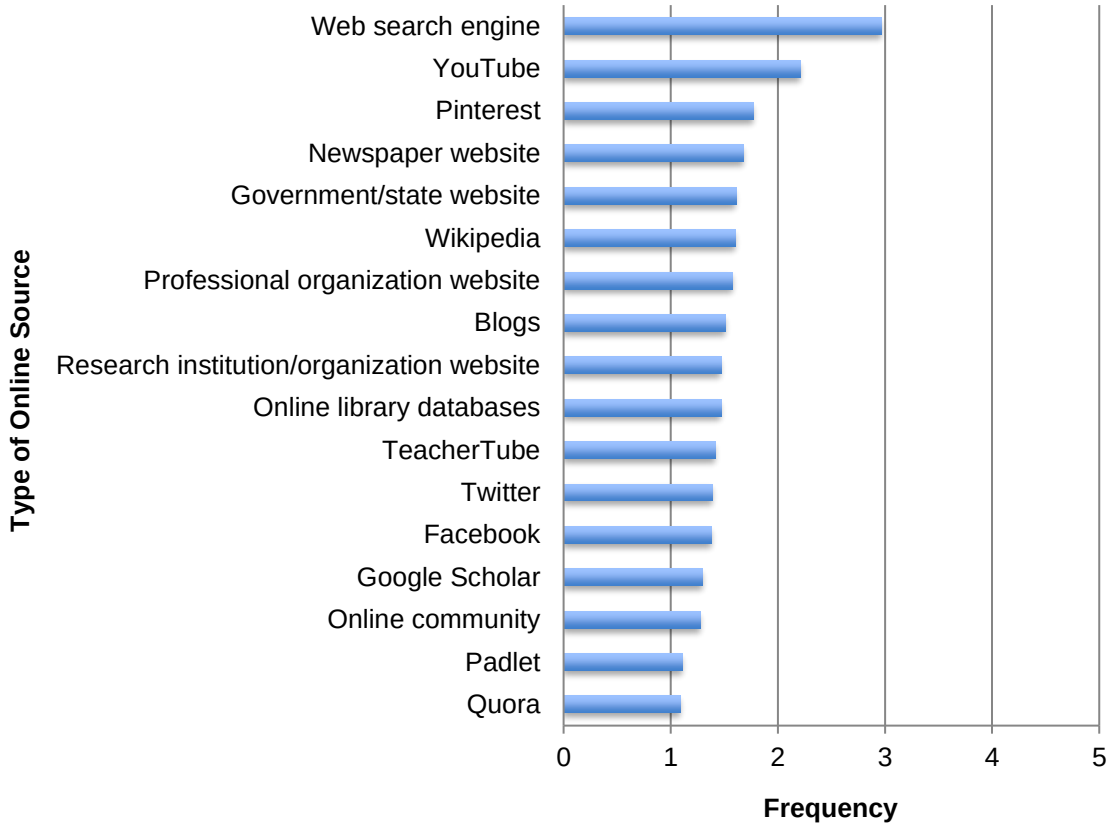

Figure 22: Online Sources and Frequency of Search (1 being *never* and 5 being *daily or more often*) for TPK Information

Teacher participants provided value ratings for online resources they have used (see Table 25). They perceived web search engines (e.g., Google, Bing) are the most valuable in finding information on technological pedagogical knowledge (*n* = 164, *M* = 3.67, *SD* = 1.02), followed by YouTube (*n* = 118, *M* = 3.37, *SD* = 1.04). TeacherTube

have less users (n = 42) than other resources among the top five most valued, but the users rated it valuable (M = 3.17, SD = 1.08). Pinterest was ranked fourth in the most valuable online sources for general instructional technology (n = 76, M = 3.12, SD = 1.05), followed by newspaper website (n = 72, M = 3.10, SD = 0.94). The least valued online sources were found to be Quora (n = 11) and online community (e.g., Edmodo, Ning) (n = 31). They were rated somewhat valuable with mean score of 2.77 (SD = 1.18) and 2.64 (SD = 1.43), respectively.

Table 25: Value of Online Sources for TPK

Online Source	*n*	*M* [a]	*SD*
Web search engine (e.g., Google, Bing)	164	3.67	1.02
YouTube	118	3.37	1.04
TeacherTube	42	3.17	1.08
Pinterest	76	3.12	1.05
Newspaper website (e.g., New York Times, Education Week)	72	3.10	0.94
Google Scholar	31	3.06	1.06
Wikipedia	59	3.05	1.06
Research institution/organization website (e.g., New Media Consortium, Pew Research Center)	53	3.00	0.83
Online library databases (e.g., EBSCO)	54	2.96	0.93
Blogs	62	2.95	1.06
Government/state website (e.g., TEA, USDOE)	70	2.93	0.97
Facebook	39	2.90	1.10
Twitter	41	2.85	1.24
Professional organization website (e.g., NCTE, AAAS, TCEA, NCTM)	72	2.83	0.93
Padlet	11	2.82	1.40
Online community (e.g., Edmodo, Ning)	31	2.77	1.18
Quora	11	2.64	1.43

Note: [a]5-point scale from 1 (*least valuable*) to 5 (*most valuable*)

By district. Between the Districts A and B, the top 3 most frequently used online sources were the same. Both teachers in Districts A and B reported using web search engines (e.g., Google, Bing) ($M_{\text{Dist A}}$ = 2.97, $SD_{\text{Dist A}}$ = 1.27; $M_{\text{Dist B}}$ = 2.97, $SD_{\text{Dist B}}$ = 1.45), YouTube ($M_{\text{Dist A}}$ = 2.16, $SD_{\text{Dist A}}$ = 1.13; $M_{\text{Dist B}}$ = 2.42, $SD_{\text{Dist B}}$ = 1.48), and Pinterest ($M_{\text{Dist A}}$ = 1.68, $SD_{\text{Dist A}}$ = 1.02; $M_{\text{Dist B}}$ = 2.22, $SD_{\text{Dist B}}$ = 1.39) for general instructional technology most frequently (see Table 26). However, online sources ranked fourth and fifth were different by district. District A teachers identified newspaper website (*M* = 1.65, *SD* = 1.02) and government/state website (*M* = 1.54, *SD* = 0.89) are their fourth and fifth most frequently used online sources. In contrast, for District B teachers, Wikipedia (*M* = 2.00, *SD* = 1.48) was ranked fourth, followed by government/state website (*M* = 1.91, *SD* = 1.23).

Table 26: Top Five Online Sources for TPK by District

Online Source	*n*	*M* [a]	*SD*
District A			
Web search engine	155	2.97	1.27
YouTube	153	2.16	1.13
Pinterest	154	1.68	1.02
Newspaper website	154	1.65	1.02
Government/state website	153	1.54	0.89
District B			
Web search engine	31	2.97	1.45
YouTube	31	2.42	1.48
Pinterest	32	2.22	1.39
Wikipedia	31	2.00	1.48
Government/state website	32	1.91	1.23

Note. [a]5-point scale from 1 (*never*) to 5 (*daily or more often*)

The teachers in District A evaluated online resources less valuable as they use them infrequently (see Figure 23). Thus, in case of web search engine, which the teacher respondents indicated most frequently using, got the highest scores on value ratings with mean being 3.63 (n = 137, SD = 1.02). This means District A teachers consider web search engine is quite valuable. In contrast, fifth-ranked resource, government/state website, was found to be the least valuable one among the top five frequently visited online resources (n = 55, M = 2.75, SD = 0.93). They felt government/state website is somewhat valuable.

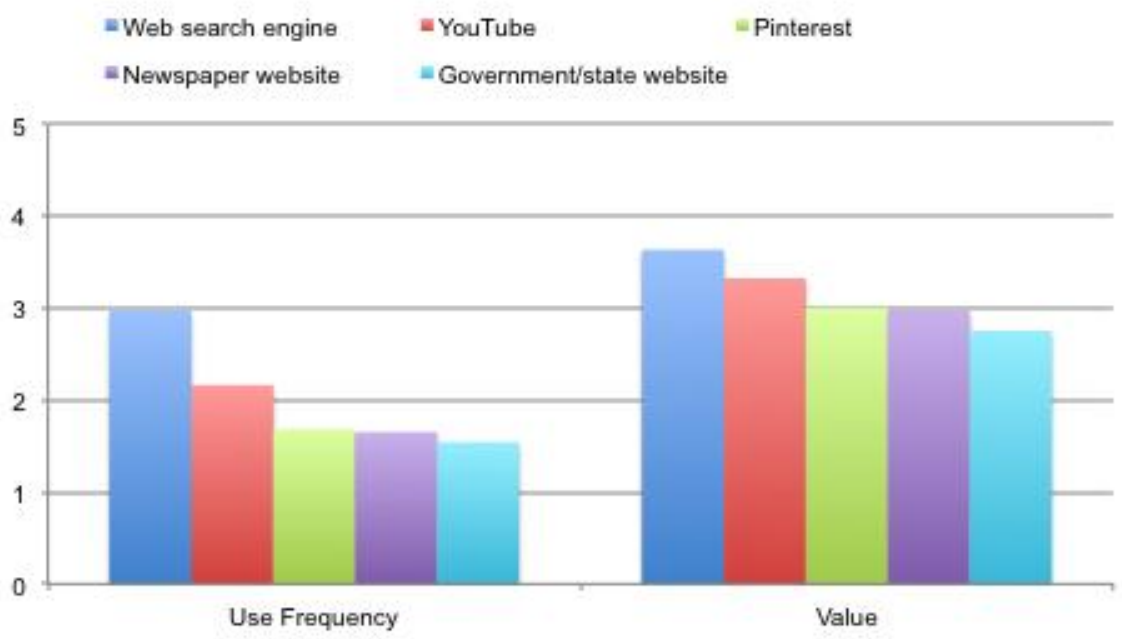

Figure 23: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TPK Online Sources for District A Teachers

District B teachers also gave the highest rating score for resource they use most frequently, web search engine (see Figure 24). However, compared to value ratings given by District A teachers, the teacher participants in District B did not show a pattern of more frequent resources being highly valued. For example, government/state website was the least frequently used online resource among the top five, but the District B teachers reported higher values (n = 15, M = 3.60, SD = 0.83) than third- and fourth-ranked resources, which are Pinterest (n = 18, M = 3.50, SD = 1.10) and Wikipedia (n = 13, M = 3.54, SD = 1.20), respectively. In addition, District B teachers showed less variability in value rating scores with maximum being 3.89 and minimum being 3.50 for the top five, compared to that of District A teachers ranged from 3.63 to 2.75.

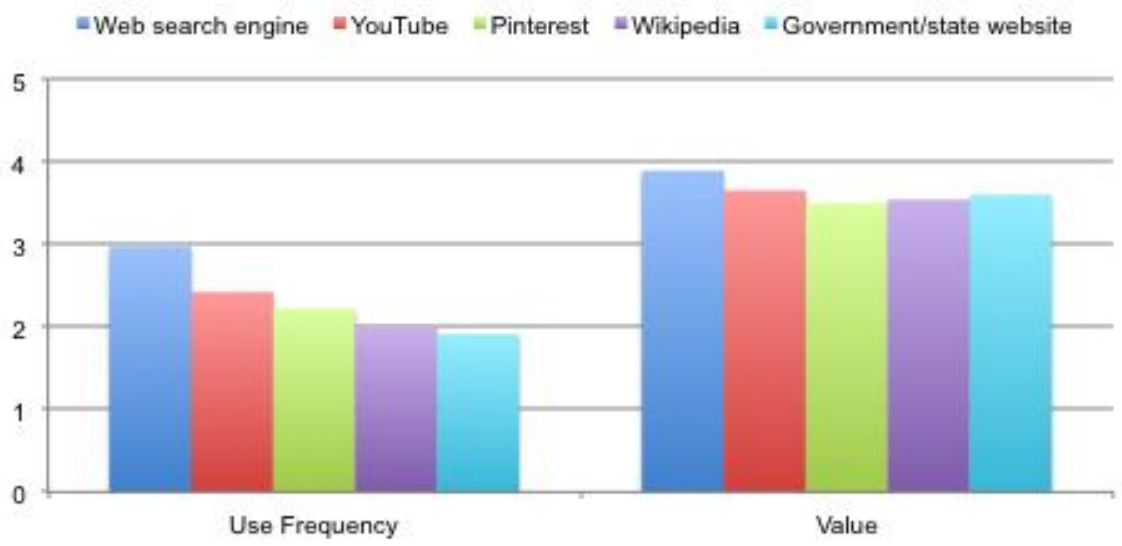

Figure 24: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TPK Online Sources for District B Teachers

By school level. When compared top five most frequently used online resources by school level, the two top sources were ranked the same across elementary, middle, and high school. All of the three school level teachers visited web search engines the most for general instructional pedagogy (M_{ES} = 3.03, SD_{ES} = 1.40; M_{MS} = 3.03, SD_{MS} = 1.31; M_{HS} = 2.82, SD_{HS} = 1.16), followed by YouTube (M_{ES} = 2.31, SD_{ES} = 1.26; M_{MS} = 2.03, SD_{MS} = 1.26; M_{HS} = 2.20, SD_{HS} = 1.12) (see Table 27). Pinterest was found to be third most visited online resource for TPK information by elementary and middle school teachers (M_{ES} = 2.15, SD_{ES} = 1.21; M_{MS} = 1.77, SD_{MS} = 1.12), but not by high school teachers. Government/state website was listed in the top five resources among elementary (M = 1.66, SD = 1.04) and high school teachers (M = 1.53, SD = 0.88), but not by middle school teachers. Newspaper website was also found to be ranked in the top five only by middle (M = 1.50, SD = 1.05) and high school teachers (M = 1.85 SD = 1.13). Wikipedia was another online resource that was included in the top five most frequently visited not all three teacher groups but two groups—teachers in elementary (M = 1.65, SD = 1.10) and high school (M = 1.56, SD = 0.99). Professional organization website was listed in fifth only by middle school teachers (M = 1.50, SD = 0.84) whereas research institution/organization website was shown in the top five only among teachers in high school (M = 1.53, SD = 0.85).

Table 27: Top Five Online Sources for TPK by School Level

Online Source	*n*	*M* [a]	*SD*
Elementary School			
Web search engine	73	3.03	1.40
YouTube	72	2.31	1.26
Pinterest	74	2.15	1.21
Government/state website	73	1.66	1.04
Wikipedia	71	1.65	1.10
Middle School			
Web search engine	32	3.03	1.31
YouTube	32	2.03	1.26
Pinterest	31	1.77	1.12
Newspaper website	32	1.50	1.05
Professional organization website	32	1.50	0.84
High School			
Web search engine	66	2.82	1.16
YouTube	65	2.20	1.12
Newspaper website	66	1.85	1.13
Wikipedia	66	1.56	0.99
Government/state website	66	1.53	0.88
Research institution/organization website	66	1.53	0.85

Note. [a]5-point scale from 1 (*never*) to 5 (*daily or more often*)

Teachers in elementary school reported the highest value ratings for the resource they visit most frequently, web search engine (n = 62, M = 3.69, SD = 1.03) (see Figure 25). However, for the resources ranked second to fifth, the value rating scores did not follow their rankings. That is, Pinterest, which was ranked third, was rated more valuable (n = 42, M = 3.29, SD = 0.89) than YouTube, second-ranked in use frequency (n = 48, M = 3.19, SD = 1.10). Wikipedia was another example that did not follow the ranking of use frequency. It was fifth-ranked online resource (n = 25, M = 3.16, SD = 1.07), but

elementary school teachers valued it more than the fourth-ranked one, government/state website (n = 28, M = 3.00, SD = 1.12). Overall, the teachers evaluated the top five online resources *valuable*.

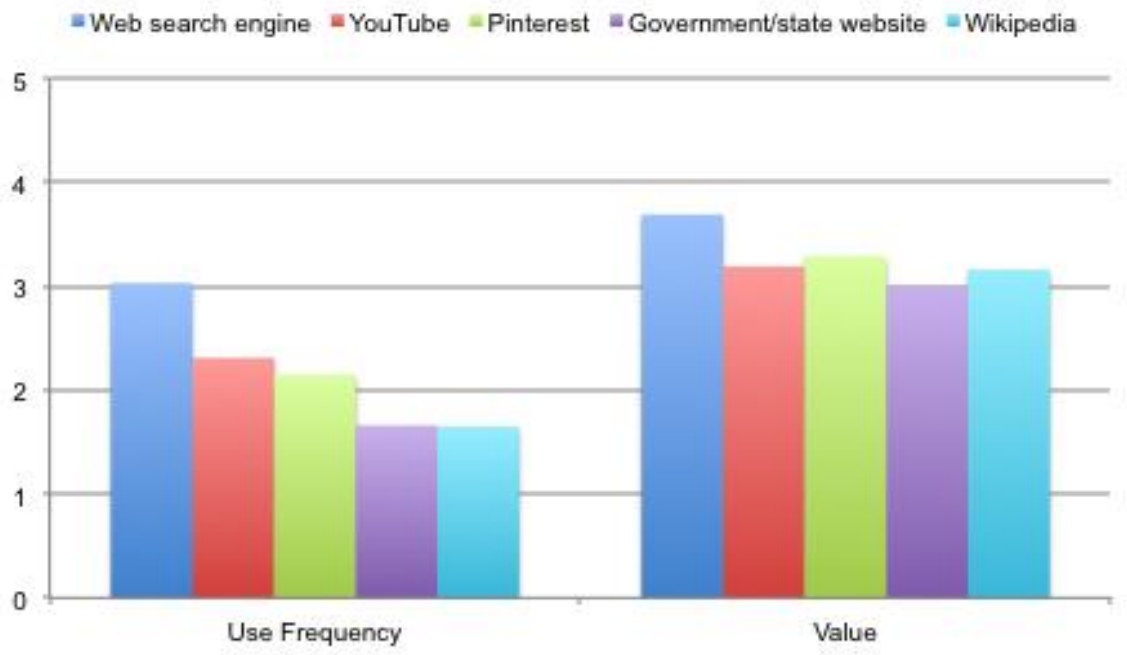

Figure 25: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TPK Online Sources for Elementary School Teachers

Middle school teachers were likely to highly value the online resources they use more often (see Figure 26). Therefore, web search engine, the number one online resource in use frequency, was rated most valuable with mean score of 3.86 (n = 29, SD = 1.03), followed by second-ranked YouTube (n = 17, M = 3.59, SD = 1.00) and third-ranked Pinterest (n = 14, M = 3.21, SD = 1.12). Although newspaper website and

professional organization website tied in use frequency score, they were valued differently with newspaper website being considered more valuable (n = 9, M = 3.11, SD = 0.78) than professional organization website (n = 12, M = 2.83, SD = 0.84).

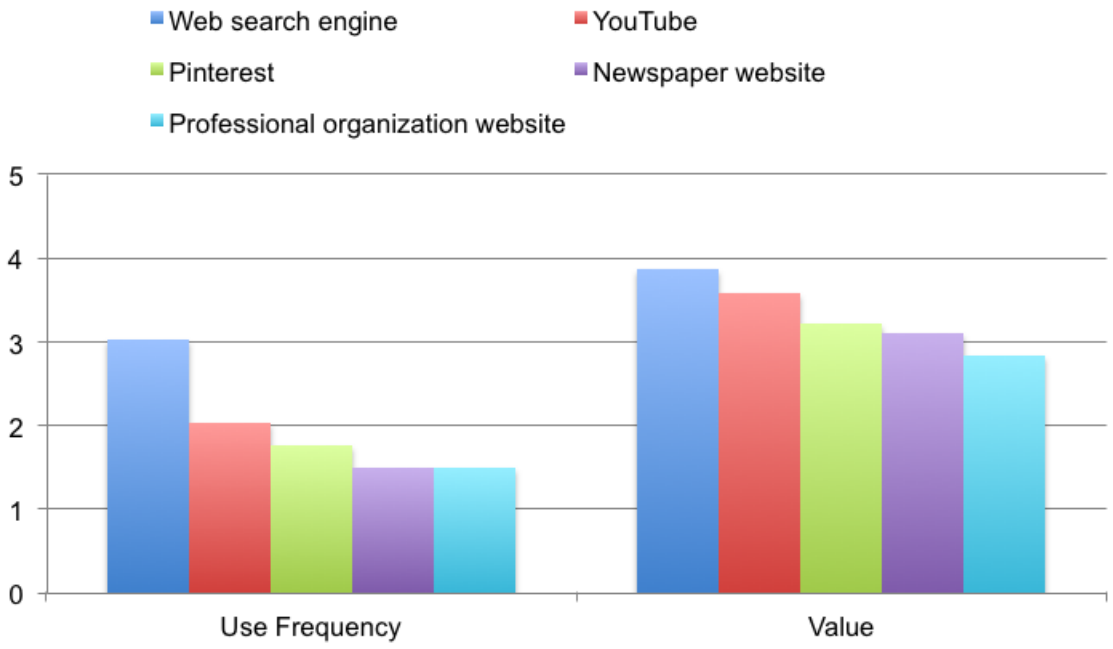

Figure 26: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TPK Online Sources for Middle School Teachers

Teacher respondents in high school indicated more values for the top three frequent resources (see Figure 27) with web search engine being the most valuable online resource (n = 62, M = 3.56, SD = 0.99), followed by YouTube (n = 45, M = 3.49, SD = 0.97) and newspaper website (n = 32, M = 3.06, SD = 0.98). The three resources—

Wikipedia, government/state website, and research institution website—which were all ranked fourth were found to be not varied widely in value ratings scores.

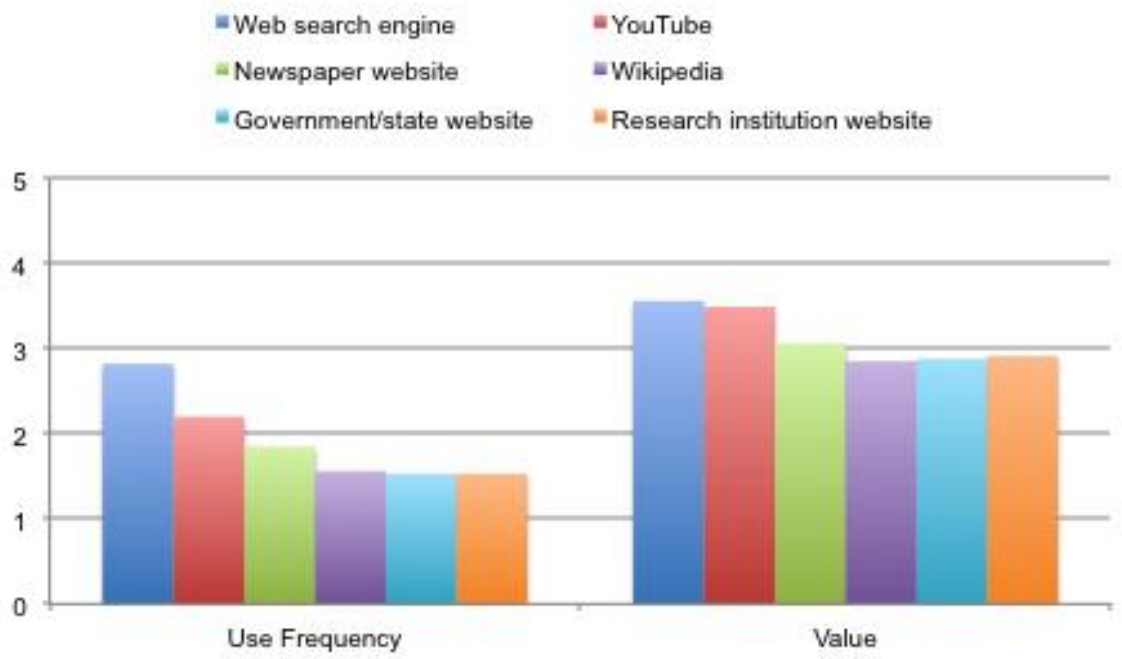

Figure 27: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TPK Online Sources for High School Teachers

By subject area. The comparison of top five online resources among teachers in four subject areas—mathematics, science, social studies, and English—was conducted to see any notable trends for using online resources for TPK information search. Like in TK and TCK, web search engine was selected the most frequently visited online source by all four groups of teachers. The mean scores ranged from 3.35 (*SD* = 1.06) by social studies teachers to 2.32 (*SD* = 1.00) by science teachers, indicating they visit web search engine

more than once or twice in a month for seeking out information about general instructional technologies (see Table 28). YouTube was ranked second across all teacher groups with mean scores of the highest being 2.82 (*SD* = 1.13) by social studies teachers and the lowest being 1.74 (*SD* = 1.15) by science teachers. Government/state website was included among the top five most frequently visited resources by math, science, and social studies teachers whereas professional organization website was ranked in the top five by all teacher groups except social studies teachers. In addition, research institution website was listed in the top five only by social studies teachers (*M* = 2.35, *SD* = 1.22) and Blogs (*M* = 1.65, *SD* = 0.99) and Pinterest (*M* = 1.55, *SD* = 1.05) are made in the top five only by English teachers.

In general, social studies teachers showed more frequent search behavior than the rest of the three groups showing the highest search frequency of 3.35 for web search engine, which means they visited web search engine more than once or twice in a week. On the contrary, science teachers reported less frequent search pattern overall. Among the top five online resources by science teachers, only web search engine was found to be used more than once or twice in a month with the other four resources being visited less than once or twice in a month.

Table 28: Top Five Online Sources for TPK by Subject Area

Online Source	*n*	*M* [a]	*SD*
Mathematics			
Web search engine	14	2.71	1.38
YouTube	14	2.07	1.64
Wikipedia	14	1.79	1.42
Government/state website	14	1.71	1.07
Professional organization website	14	1.64	1.08
Science			
Web search engine	19	2.32	1.00
YouTube	19	1.74	1.15
Newspaper website	19	1.42	0.96
Government/state website	18	1.39	0.98
Professional organization website	19	1.37	0.96
Wikipedia	19	1.37	0.96
Social Studies			
Web search engine	17	3.35	1.06
YouTube	17	2.82	1.13
Newspaper website	17	2.59	1.37
Research institution website	17	2.35	1.22
Government/state website	16	2.13	1.46
English/English Language Arts			
Web search engine	20	2.75	1.07
YouTube	20	2.10	0.97
Newspaper website	20	1.75	1.07
Blogs	20	1.65	0.99
Professional organization website	20	1.55	0.95
Pinterest	20	1.55	1.05

Note. [a]5-point scale from 1 (*never*) to 5 (*daily or more often*)

The value ratings of mathematics teachers showed a unique pattern. Even though web search engine ranked the first in use frequency, math teachers did not give the highest rating. Rather, they perceived YouTube most valuable with mean score of 3.83 (n = 6, SD = 1.17) (see Figure 28). The second valued resource was Wikipedia, the third-ranked in use frequency. Government/state website was reported to be the least valued resources among the top five (n = 7, M = 2.86, SD = 0.90).

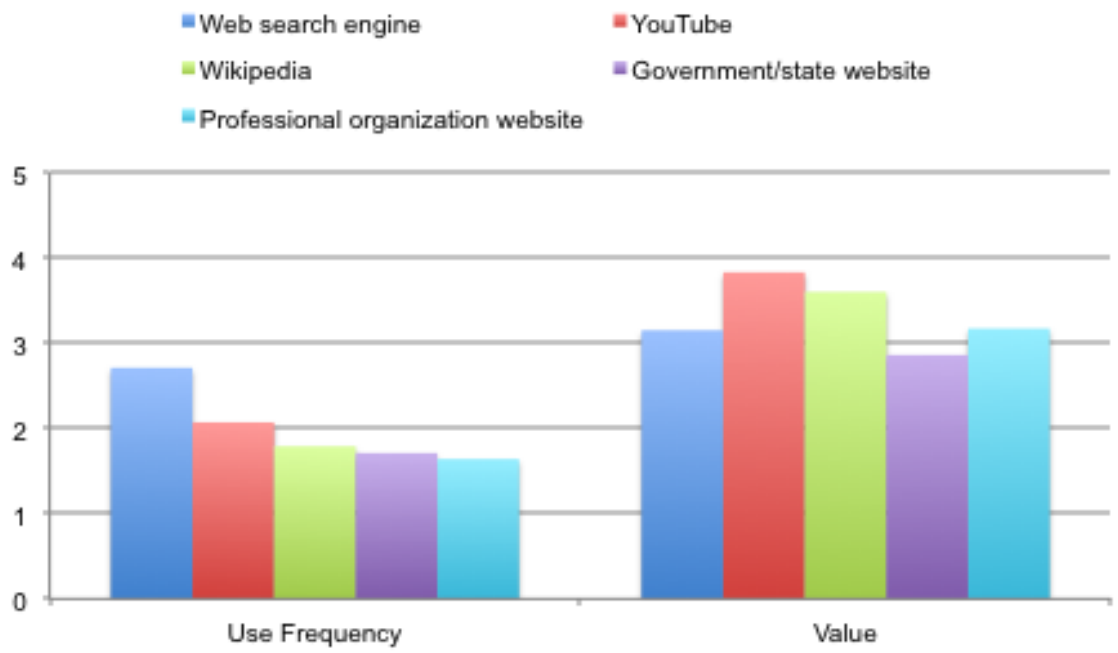

Figure 28: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TPK Online Sources for Mathematics Teachers

Despite overall low use frequency, science teachers provided high value ratings to the top six resources they used frequently when searching for TPK information (see Figure 29). In addition to web search engine, which was ranked first in use frequency, YouTube and professional organization website were highly valued by science teachers, both of which scored 3.5 in value ratings. Wikipedia was given higher value rating scores (n = 4, M = 3.00, SD = 1.16) compared to its rankings in use frequency.

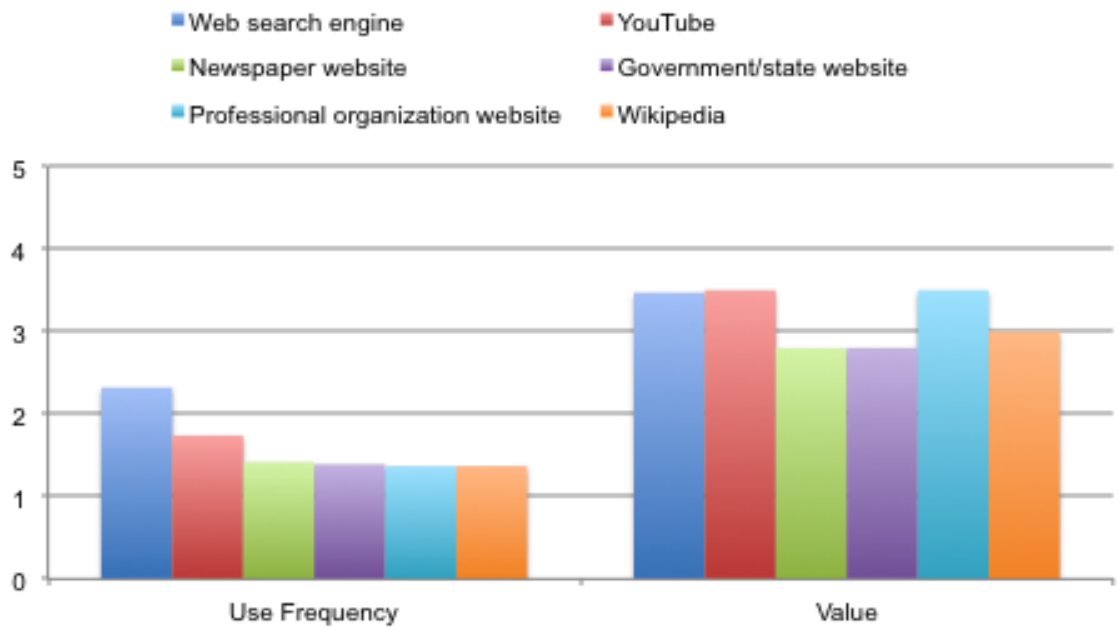

Figure 29: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TPK Online Sources for Science Teachers

The value ratings of online resources by social studies teachers followed the order of use frequency rankings (see Figure 30). Web search engine was found to be the most highly valued (n = 17, M = 3.88, SD = 0.70). One exception was made to government/state website, which was ranked fifth in use frequency but slightly rated higher (n = 9, M = 3.22, SD = 1.09) than research institution website, the fourth-ranked in use frequency. The overall value rating scores did not have a big gap between the highest and the lowest scores.

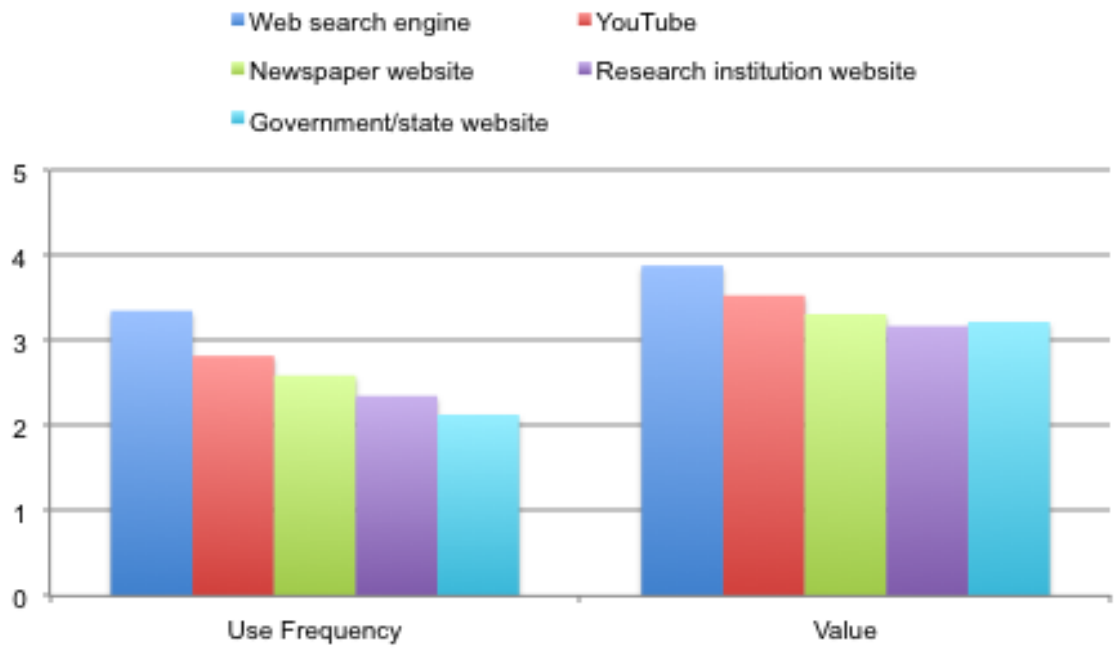

Figure 30: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TPK Online Sources for Social Studies Teachers

English teachers value ratings scores appeared to be similar to that of social studies teachers—as the online resources were used frequently, they were more likely to be perceived valuable (see Figure 31). In addition, as in the value ratings made by respondents teaching social studies, the range of value rating scores by English teachers' did not show a big variance, with the highest being 3.47 (n = 19) and the lowest being 2.75 (n = 8).

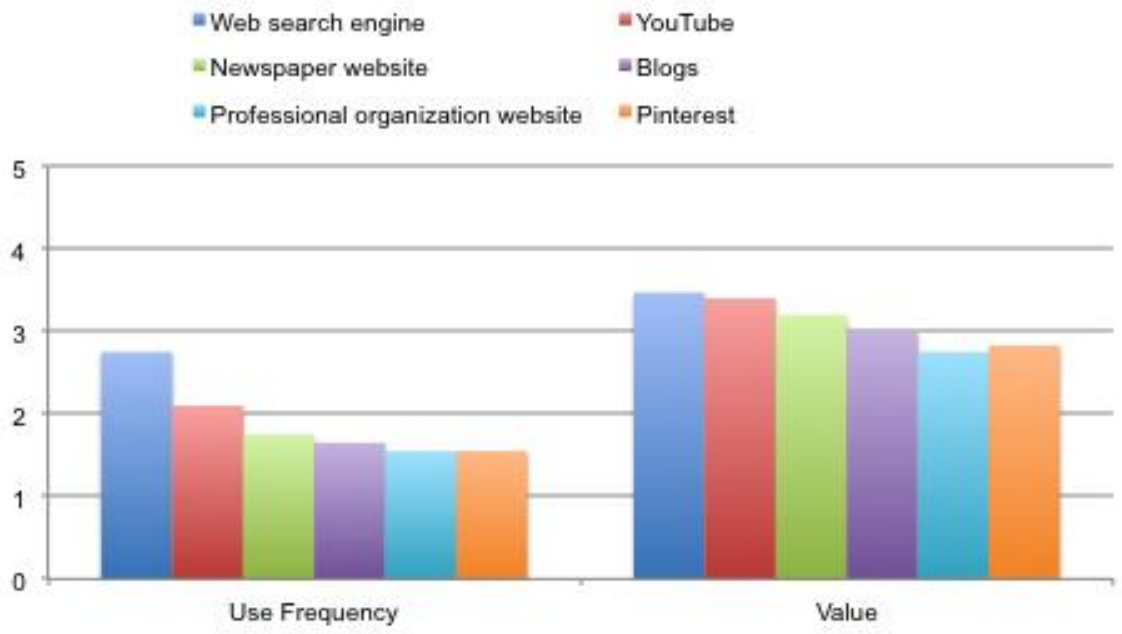

Figure 31: Use Frequency (1 being *never* and 5 being *daily or more often*) and Value Rating (1 being *not valuable* and 5 being *extremely valuable*) of TPK Online Sources for English Teachers

Teacher experiences with online resources. The interviews with Districts A and B teachers provided further explanation on their use of online resources.

Use of various online resources. From the survey results, it was found that some teachers used various online resources, not limiting their information source for one or two specific ones. When asked the reasons for using several different resources for seeking information online, Taylor, a teacher in District A, mentioned different needs for different students. She said, "you often have different kids that aren't getting something or something that's just not clicking with this group. So you're always looking at adjusting for your classes and your specific students. And so that's where I really find the research tools very helpful. It helps you meet the needs of the students that you have at that time." In another case, it was originated from teachers' personal habit. For Wyatt, a social science teacher in District A, it was a personal approach to searching he had. Especially for technology integration, he wanted to see "what everybody is doing." So, he "cast[s] the widest possible to try and find the information" he wants and once he had all that information, he "refines [while] constantly looking for newer stuff as well."

Purposes for using certain online resources. The qualitative interview also inquired why and how teachers used certain online resources. The first major online resources reported to be used frequently by teachers included Facebook, YouTube/TeacherTube, and Pinterest.

Facebook for teacher community group. Teachers visited Facebook for teacher community group. Naomi and Wyatt both appreciated the Facebook community group because they were able to find useful information and materials posted by other teachers

teaching same subject as them. Naomi said, “there are a lot more professional groups that are in there and places where you can get good information.” Wyatt was a novice teacher who recently started his teaching career. In this first month of teaching his subject, he was trying to figure out how to do it and ended up finding the Facebook group, which he said “incredibly helpful.” He described the Facebook group as follows:

> You have people who are helping organize the information so kind of playing the role of like a librarian. Like it's a very self-organized community for teachers which I think is incredibly helpful. Because I had a web of peers who are experts at teaching this, I could ask questions. And they actively encouraged that once you have learned enough then you can start to help those who have questions as well. And so I think it's one of the problems in teaching that you feel like an island you feel very isolated. So I use it more of a tool to find peer reviewed validated data showing how to run a course. Less so specific ideas on like how to but like more big picture.

YouTube/TeacherTube. YouTube was mainly used for seeking out either technological know-how or videos for classroom use. Naomi, a high school teacher in District A, explained that she went on to YouTube when she was trying to figure out how to do something with technology. She mentioned, “YouTube has a lot of really good tutorials in it.” Similar remarks were made by Liam and Iris, both of who are middle school teachers in District A. Liam said, “YouTube is more like how to do something.” He explained when YouTube is useful in searching for technical guidance, “If I want to know how to actually edit something or whatever software I am trying to use and I am

not sure exactly the process and I don't want to just mess around with it." Furthermore, Iris used YouTube not only for her own technological know-how but also for her students as she described:

> So a lot of times when I'm searching for directions and stuff I'm like looking for YouTube videos on how to use this. I'm looking for how I install this on my iPad. I'm looking for like the tricks and stuff. And then I'll do it on my iPad and then I'll make usually Google slides of step-by-step directions.

Teachers also visited YouTube to look for videos that can be used in classroom teaching and learning. As a elementary school teacher, Kate described YouTube had been her "main science supporter in regards to videos." She liked to go on to YouTube, seeking out, for example, "video of some experiments" or "habitat of different animals." Additionally, one teacher participant, Taylor, mentioned TeacherTube, whose use was similar to that of Kate. Taylor, an middle school English teacher in District A, described that she used TeacherTube to look for warm-up videos for what the class would be doing on a certain day. She often searched for short video clips (e.g., a five-minute introductory video), from which she then built the rest of class.

Pinterest. Teacher interviewees reported their use of Pinterest for visual materials. In Taylor's case, she favored the fact that Pinterest allowed her to share information visually. She gave an example of using Pinterest, "If I'm looking for scary stories I can type that in and it will give me a range of things that I can pull from to share with students. And then I'm a picture person, too. So I like to be able to have visuals." Kate mentioned she used Pinterest to find materials for teaching and learning purposes, "I love

using Pinterest looking for different learning games or different activities to do. So I like using Pinterest to find different fun, hands-on things that they [students] can do."

Channels for introduction to online resources. Interview results revealed that teachers got introduced to online resources through various channels. Taylor talked about district-wide PD that she attended, "our district does professional development and kind of a two-, three-day big push so I often times get different apps or ideas from that." Naomi also mentioned, "I found out about them [online resources] when I was at a summer professional development conference." Some of teachers in District A also mentioned their Ed Tech specialist or librarian as a provider of information source. Other instances of introduction to online resources happened by chance or through teachers' own learning endeavors.

Summary

The data analysis found that the most searched information area among teachers was TCK, followed by TK and TPK. The order of the searching frequency was shown to be the same across two school districts. However, District A teachers reported less frequency in searching information online than District B teachers in all three knowledge types. Qualitative interview data results revealed possible explanations for this finding in that District A provided support for teachers in various formats whereas District B teachers had limited resources available. Middle school teachers were reported to be the most active seekers for TK and TCK information online. For TPK, elementary school teachers indicated searching the information the most. Regardless of the knowledge areas, social studies teachers reported searching information online most frequently

whereas science teachers showed the least active information searching frequency in all three knowledge types.

Web search engine and YouTube were ranked top five by all school districts, school levels, and subject area teachers. Pinterest, Facebook, newspaper website, and Wikipedia were often included in the top five rankings in the three knowledge areas. Overall, teachers were more likely to give higher rating scores to online resources they used more frequently.

Chapter 5: Discussion

The purpose of this research was to understand the teacher experience of online information searching with regard to technology integration, and by doing so, to find ways to better support teachers who are creating technology-integrated instruction. This research applied a mixed method design of research to explore the characteristics of online information search activities among teachers in two school districts. The final chapter of the research interprets the findings, provides recommendations, and presents suggestions for future research and the limitations of this study.

Interpretation of Findings

Prevalent issues that emerged from the findings include: TCK and TK as the most searched information among teachers, teachers' perceptions of lack of resources, and a stark difference in teacher support provided by Districts A and B.

Needs for content-specific technological information (TCK). The survey results of the current study showed TCK is the most searched information among three sub-types of TPACK used in this study (i.e., TK, TCK, and TPK) by teachers across districts and in each district. Specifically, it was reported that, among three items in TCK, teachers searched the most for various subject-specific technologies for their content areas, which can include examining primary source apps for English and looking for Google Earth lessons for social studies. TCK being most searched knowledge area can be interpreted that teachers need more knowledge for technology integration closely related

to their subject area. In a study on preservice teachers in a laptop-infused teacher preparation program, Hughes (2013) reported that the preservice teachers demonstrated lack of perceived value for content-specific technologies, which would hamper their improvement in knowledge for technology integration.

The findings in this study are in accordance with previous research pointing out the needs for content-focused technology integration PD. Previous studies reported teacher PD for technology integration was not specific to content area (An & Reigeluth, 2011) and was limited to the basic level of information on technology (Liu et al., 2018).

Jimoyiannis (2010) asserts that dominant models for ICT integration follow the stage-based models, which are characterized by "teachers' and students' development and movement from lower to higher levels of technology use and integration" (p. 1260). Under the stage-based framework, teacher technology PD is more likely to focus on technological know-how (TK) with less attention to pedagogical issues on how and why teachers use the new technology (Jimoyiannis, 2010). The stage-based PD was evidenced in Liu and colleague's (2018) study, which examined PD in a school district that implemented an iPad initiative. In the study, PD opportunities available in the district were mostly about technological skills with rare instances relevant to subject areas. In my study, District A distributed iPads to students in their high school first under a 1:1 iPad initiative. In District B, all teachers had laptops and iPads, but students in elementary and middle schools had to share iPads while all high school had 1:1 iPad. Thus, given the fact that District A and District B recently started technology initiatives, more efforts were made to TK to ensure every teacher has an understanding of the new devices.

As teacher participants mentioned in the interviews, both District A and District B provided PD sessions for teachers on how to use technology. However, in District B, PD on technology integration was mainly about technology skills and software programs. The PD offerings usually lasted several hours in a day as a "refresher" and barely introduced content-specific resources such as subject-specific apps. In case of District A, although intermediate and advanced level of PD sessions were offered, they were optional and only introductory technology trainings (e.g., how to use a new technology) were mandatory. Accordingly, the PD in both districts likely contributed to why TCK was reported to be the most searched information than other knowledge types (i.e., TK and TPK) by the teachers in the two districts because their professional learning primarily focused on TK or TPK.

When technology PD is content-specific, teachers learn about using technology for teaching and learning subject matter content (Kersaint, Ritzhaupt, & Liu, 2014). Kersaint, Ritzhaupt, and Liu (2014) investigated the effect of a yearlong technology integration PD that had a specific focus on mathematics and science. The research found that notable changes in teacher perception and knowledge tended to emerge when teachers received content-specific PD. Therefore, if the goal of PD is to enhance the teaching and learning in specific content area using technology, PD need to be directly connected to content-specific technologies rather than to cover generic technology tools.

Sustained support needed for technological know-how (TK). Familiarity with and ability to navigate classroom technologies have proven to be an important factor for

teachers to integrate technology in teaching and learning (British Educational Communications and Technology Agency [Becta], 2004; Davis, Preston, & Sahin, 2009).

From the study findings, it seems that even after the introductory technology training is provided, support for TK is still important to ensure that teachers are being updated with new technology and to deal with any technical issues arising during instruction. In the current study, teachers' information search about technological know-how (TK) was the second most searched area among teachers in both Districts A and B. Interviews with the teacher participants confirmed their needs for sustained support for TK. Although District A teachers reported searching TK information less than District B teachers possibly because of in-house Ed Tech specialists in their campus, the teachers in District A needed technical support whenever new technologies were employed. District B teachers also expressed difficulties to remember troubleshooting process when similar technical malfunctions happened. This indicates that it is crucial for teachers to receive sufficient technology support continuously. The findings are aligned with Liao, Ottenbreit-Leftwich, Karlin, Glazewski, and Brush' (2017) study that examined changes in teachers' needs for PD content and format over the 6 years. The study found that teachers' need for just-in-time/in-class support had increased from 0% (n = 1) in 2009 to 31% (n = 52) in 2015 (Liao, Ottenbreit-Leftwich, Karlin, Glazewski, & Brush, 2017).

The interview results further revealed a big disparity in terms of the availability of technical support in District A and District B, respectively. Teachers in both Districts A and B had an access to IT specialists in their district. However, District A teachers had not only IT personnel who oversaw the whole district but also an in-house Ed Tech

specialist who was readily reachable. On the contrary, teachers in District B only had access to district-wide IT specialists. Thus, in the case of District B, when teachers did not have sufficient support for using technology in classroom, it made them disappointed and frustrated. Research indicates that limited technical support was one of the major obstacles to teachers in using technology in classrooms (Ertmer, 1999; Inan & Lowther, 2010; Mouza, 2009).

When human support is lacking, online information may provide the "just-in-time" support that might avoid the situation of a teacher feeling discouraged and not persevering in using the technology. For District A teachers, even though they were able to reach out to district IT personnel and on-campus Ed Tech specialist, they sought technological information online, looking for step-by-step guides on how to do things with technology. Also, it was one of the reasons why they went to YouTube. This way, they did not have wait for the technology person to come.

Lack of high-quality, reliable resources. Teachers in both Districts A and B reported using various online resources in seeking out information about technology integration. Web search engine, YouTube, Facebook, Pinterest, Wikipedia, and newspaper website were most commonly ranked resources in top five across districts, school level, and subject areas. The different online resources served different purposes. YouTube was found to be most useful for technology tutorials for teacher learning and content-related, warm-up materials for student learning. Facebook functioned as a learning community where teachers asked questions, found materials, and shared ideas for teaching. Pinterest was useful for teachers collecting relevant materials in boards and

sharing them not only with other teachers but also with students. Existing literature supports the findings in that teachers visited Facebook either to share their experience as a teacher or to be updated on a certain topics (Ranieri et al., 2012), and Twitter was considered as a place where teachers have access to new ideas and stay informed with emerging educational technologies and trends (Carpenter & Krutka, 2015a).

District A and District B teachers showed a pattern of giving higher value ratings to online resources they used more frequently. However, qualitative data revealed that teachers were still in need of high-quality resources for technology integration. Teachers expressed that even web search engines, the number one online resource teachers visited and valued the most, did not provide satisfactory search results because many of the results were neither useful nor in high quality. The teachers had to spend more time to sort things out or to edit the online resources in a way they wanted to use them in classrooms. Accordingly, this made them discouraged to seek out information online. However, at the same time, this shaped their strategy for online information seeking, ensuring reliable resources. Whenever they found a good source, they tried to keep track of it by, for example, following an organization or a good technology user in Twitter.

Different levels of support by district. Research has shown that the technology-integrated classroom can be more successful when it is undergirded by the district-wide support (Ertmer & Ottenbreit-Leftwich, 2010; Hughes, Boklage, & Ok, 2016; O'Hara, Pritchard, Huang, & Pella, 2013). In this study, it was found from the survey results that District A teachers reported searching information online less than District B teachers regardless of knowledge areas (i.e., TK, TCK, and TPK). The interviews with teachers in

both districts revealed that teachers in District A were provided supports from the district in diverse formats (e.g., support from Ed Tech specialist, PLC, PD within and outside of campus, conference attendance), which could explain why they sought online information less frequently. Most of them showed satisfaction with available learning opportunities and the way district promoted the opportunities. In contrast, District B teachers desired for more PD opportunities geared toward using technology better in classrooms.

Personalized support. Having technology support is a first step to technology integration in schools. With the dedicated support for technology, teachers feel relieved, thus making them try to use the technology in classroom (Inan & Lowther, 2010). All school campuses in District A had an in-house Ed Tech specialist who provided on-site technology trainings and individual support to teachers in the campus. The Ed Tech specialists helped teachers familiarize with technology and figured out basic technological issues. Different from District A, however, District B did not have many resources available on campus. Although a teacher participant mentioned her IT department was helpful, providing help in finding apps, they were technicians, whose goal focused on solving technical issues rather than technology-related instructional support. Moreover, the IT personnel were in central district office and always busy taking care of issues district-wide. The finding complements Cuban, Kirkpatrick, and Peck's (2001) study where the technicians felt overwhelmed by the amount of teacher requests, thus leading them not to be able to respond in a prompt or adequate way. The teachers in District B had to put a special request whenever they needed help and waited for them to come, which could possibly hinder them from trying out technology-based instruction.

More important, District A teachers were provided support from Ed Tech specialists who shared new technology tools and teaching practices with the technology and brainstormed ideas together with subject area teachers. This can be considered as a mentorship or a coaching model of technology PD. These models were suggested to provide individualized support for teachers in implementing technology-focused instruction, complementing the disadvantages of one-shot, technology skill-oriented PD offerings (An & Reigeluth, 2011; Glazer & Hannafin, 2006; Kopcha, 2012). Literature emphasized the necessity of personalized supports that are geared toward teachers' specific needs (Hixon & Buckenmeyer, 2009; Kopcha, 2012; O'Hara et al., 2013). By working together with the mentor and coach, teachers are given personal support not only for troubleshooting but also for their learning needs and technology skill level.

Professional learning opportunities. In District A, teachers participated in PLC meetings, through which they learned and shared new ideas, successful stories, and troubleshooting experiences on technology-integrated classroom practices. Previous studies report the positive outcome of teacher participation in community of practice. Most teachers showed improved ability, after a yearlong engagement in a community of practice, for planning and implementing technology-integrated teaching and learning (Glazer & Hannafin, 2008) and frequent use of technology in instruction (Hughes & Ooms, 2004).

In addition, teachers in both Districts A and B mentioned district-wide PD opportunities were available for technology integration. However, the interview results found the PD they were provided quite different. District A teachers were offered

required introductory trainings. In addition, they were offered PD at different time points throughout the school year with various options for teachers at different levels in integrating classroom technologies. Long-term, sustained PD support has been pointed out as a crucial factor for successful technology integration (Gerard, Varma, Corliss, & Linn, 2011; Walker et al., 2011).

During a school year, District A teachers toured other school campuses in their district to learn what and how other teachers are doing successfully with technology. In summer, they took part in an annual tablet-computing conference initiated by District A. The teachers appreciated the learning opportunity and indicated it very useful. Furthermore, the teachers in District A were encouraged to attend conferences for technology integration even during a school year. They were supported financially for conference registration, and substitute teachers covered their classes. The findings are in accordance with studies that indicated positive impact of sustained, situated teacher PD with hands-on practices in authentic environments (Duran, Brunvand, Ellsworth, & Şendağ, 2012; Kopcha, 2012; O'Hara et al., 2013).

On the contrary, District B teachers desired more PD opportunities with more useful resources. They wished for introduction to helpful apps and programs, and more explanation on how they can use technology for better teaching and learning without being told, "here it is" as well as time to play around with the device. The District B teacher's wish supports the assertions from prior studies that argued more time and PD opportunities for teachers' technology integration (Potter & Rockinson-Szapkiw, 2012;

Wells, 2007). Consequently, the lack of support available to them might have had teachers in District B search more for information online.

Recommendations

Supporting teachers for technology integration takes efforts from multiple aspects. It is important to have a multi-lateral support plan that simultaneously provides knowledge development of TK, TCK, and TPK and help teachers develop skills for online information searching. The ultimate goal of the current study was to contribute to teacher support mechanism that will enable teachers to improve practices for technology-integrated teaching and learning. Thus, in the following section, I would like to provide recommendations for: (a) teachers, (b) Ed Tech Specialists and Librarians, and (c) PD program developers and K-12 administrators.

Teachers. As indicated by teacher respondents, teachers were utilizing a variety of online resources to search for information regarding knowledge on technology integration (i.e., TK, TCK, and TPK) by, for example, following colleague teachers or joining teacher online community groups. Continuing advancement in technology made it possible for teachers to seek out online information and be connected for the purpose of professional growth without limitation, which implies that teachers do not have to wait for knowledge to be injected through district-provided PD offerings. Rather, they can be more active in seeking information and creating professional learning opportunities online.

Joining online teacher communities can be one way for teachers to become proactive learners. Numerous research reported advantages of using online communities for teacher professional development. For example, preservice and inservice teachers who participated in an online community of practice called Nurturing Elementary Teachers' work (NETwork) perceived the community as a supportive tool for their current and future teaching (Tsai et al., 2010). In another study, Wang and Lu (2012) explored Chinese teachers' use of an online community, where the community served as a place for the teachers to plan and reflect lessons while giving feedback and sharing resources. From this case study, the authors demonstrated that the participant teachers used the online community for obtaining subject knowledge, peer feedback, and support while sharing experiences and resources, all of which contributed to teachers' development professionally. By joining online teacher communities, teachers will be able to share resources, exchange ideas, and learn from fellow teachers who are even geographically separated (Lieberman & Mace, 2008).

Using Web 2.0 tools, such as Facebook, Pinterest, Wikipedia, and Twitter, can be another way for teachers to be updated with instructions with new technology tools, sharing good technology-integrated classroom practices. Burden (2010) described how teacher learning can be facilitated through diverse Web 2.0 tools. He, for example, suggested Wikis can be used to support knowledge construction among teachers whereas VoiceThread can be a useful medium for reflective and collaborative activities (Burden, 2010). As such, online social networks are recognized as most common forms of teacher learning with digital technologies (Borko et al., 2009).

It would be also worthwhile for teachers to take part in Connected Educator Month (CEM). The CEM was launched by the U.S. Department of Education in August 2012 and reflects a federal emphasis on teacher learning through online communities. During the CEM, which is now held in every October, educators have opportunities to participate in free learning events hosted virtually and to collaborate with others through online networks for their professional development (U.S. Department of Education, 2013).

Taking a step further, teachers can even create a web of knowledge using, for instance, Wiki pages or blogs. This web of knowledge can be co-built by individual teachers in each school campus or even across school campuses in their district and work as a place to share their experiences, resources, and ideas. Especially, for TK, it would help save teachers' time to look for information online or wait for a technician come if teachers share useful features of new tools or common issues on troubleshooting.

Ed Tech specialists and librarians. The study results revealed that TCK is the most sought knowledge area among teacher participants, and District A teachers were being helped by on-campus Ed Tech specialist with not only just-in-time technological support but also how to incorporate technology to enhance student learning. As such, it would be important for Ed Tech specialists to provide personalized support to teachers so that they can enrich technology-infused lessons. Even with PD offerings, it is possible that the PD lacks content focus and covers basic technological topics as evidenced by previous studies (e.g., An & Reigeluth, 2011; Liu et al., 2018). Under these circumstances, the Ed Tech specialists can play a pivotal role, filling the gap that PD

opportunities were not able to fulfill and, at the same time, accommodating individual teachers' technology proficiency level. Librarians can also strive to help teachers by supporting them to improve skills and strategies for TCK development and sharing useful resources and information on a regular basis.

In addition, both Ed Tech specialists and librarians on campus can lead teachers' endeavor of creating web of knowledge, providing them guidance and relevant resources. Studies report that teachers are engaged in online learning activities via various tools such as online teacher community, Facebook, and Twitter (Carpenter & Krutka, 2014; Hur & Brush, 2009; Ranieri et al., 2012). Utilizing and contributing to the web of knowledge would serve similar purposes among teachers for participating in learning activities online.

PD program developers and K-12 administrators. When a district starts a technology initiative, different elements need to be considered if the aim is to achieve enhanced student learning by transforming the existing instructional practices. PD trainings solely focused on technology skills can function as a barrier to technology integration (Kopcha, 2012; Mouza, 2009). As suggested by ISTE standards for educators, teachers should be able to "continually improve their practice by learning from and with others" and "facilitate learning with technology" by "dedicat[ing] time to collaborate with both colleagues and students to improve practice, discover and share resources and ideas, and solve problems." (International Society for Technology in Education, 2017). To better support teachers for technology-focused teaching and learning, K-12

administrators should consider the followings: connecting human support and online information-seeking, and diversifying PD content and format.

Connecting human support and online information-seeking.

Increasing Ed Tech specialist availability. Having dedicated support for technology integration can help teachers feel relieved when they do not know much about technology, thus making them try to use the technology in classroom. The in-house Ed Tech specialist can function as a mentor and/or coach who can provide individualized support, complementing district-wide PD trainings. The mentor approach in PD can be effective when pursuing instructional improvement with the use of technology (Potter & Rockinson-Szapkiw, 2012). Mentored teachers showed increased confidence with technology and implemented more student-centered technology-based lesson than those who did not have mentored-support (Lowther, Inan, Strahl, & Ross, 2008). In contrast, when teachers felt technological resources were insufficient, they did not try to become proficient in technologies (Swan & Dixon, 2006).

Creating an information hub. Under circumstances where human supports are not readily available, an information hub that collects necessary and relevant information on technology integration can help teachers. This can be simple as a webpage with links to other information sources and brief descriptions. For example, the webpage can feature Facebook communities for social science teachers that will be useful to develop TCK or a YouTube tutorial that walks through how to use a Garage Band on iPad that enhances teachers' TK.

Especially for TK, an online space, such as a YouTube channel, that stores short video clips on information for technology integration can be also beneficial to teachers. Instead of having an hour-long PD in the beginning of a school year, a "bite-sized" video for TK can better meet teachers' needs, providing "just-in-time" support. The short clips on instructional idea with technology use will be able to provide a "food-for-thought" to teachers, inspiring them to explore transformative, innovative ideas for using technology in instruction.

Furthermore, by uploading all materials relevant to district-wide technology integration, teachers can refer to them whenever needed. Such examples can include district-wide technology PD recordings, learning materials used in the trainings, and PowerPoint slides presented by guest speakers. Altogether, the online information hub containing useful knowledge will benefit teacher for active learning toward technology integration.

For instant support, a district may want to consider having a closed social media channel. Such example includes Slack, a social media with closed membership. Through communications in Slack, teachers could be able to pose a question and get answers shortly, which will help decrease time for waiting to have the problem resolved. The Slack channel can also be a place for teachers to share ideas and information.

Diversifying PD content and format. In the initial stage of technology rollouts, more efforts might be made to TK to ensure every teacher has an understanding of the new device. However, moving forward to second and third year of technology initiative, it will be of more importance to provide trainings on how to incorporate technology from

an instructional aspect and especially with a focus on subject-specific area. As evidenced in the literature, a "one-size-fits-all" approach to technology PD will not result in positive impact on technology-infused instruction (Hixon & Buckenmeyer, 2009). Furthermore, often times, not all teachers in 1:1 technology implementation were able to use technology in an amplified or transformative way (Hughes et al., 2017). Rather, they adopted technology to accord with an existing curriculum (Milman et al., 2014) or used technology as a replacement for paper-based materials (Hughes et al., 2017). Thus, PD opportunities that cover various content with a particular focus on TCK need to be offered to teachers.

Moreover, PD content needs to be expanded to include skills on online information searching and how to use social media to promote teachers' knowledge development for technology integration. As the study results on teachers' online information-seeking frequency showed, it became common for teachers to go online to search for information regarding technology-integrated teaching and learning. Teachers' online search frequency being approximately once or twice in a month for all three knowledge areas of TK, TCK, and TPK implies the importance of supporting teachers to yield fruitful search results.

The various formats of PD also need to be considered to better support teacher for technology integration. Different types of PD have been proposed and studied. Most common ones explored previously are one-shot workshops, design-based approach, a mentoring or coaching model, and a train-the-trainers model, and each one has its pros and cons (Lawless & Pellegrino, 2007). For instance, one-shot workshops can be

effective in the early phase of technology rollouts or when basic trainings for technology skills need to be provided. However, in pursuit of change in classroom teaching practice with technology, a mentoring or coaching model will be useful with personalized support and feedback to improve technology-integrated teaching practices (Glazer & Hannafin, 2008). Thus, with more options available to teachers, it is more likely to support teachers to integrate technology effectively (Liao et al., 2017).

Recommendation for Future Research

The current study explored teacher information search activities and therefore informs support strategies for teachers' technology integration. In order to provide better support with a full understanding, much more research is needed.

First, further studies on the relationship between teachers' perceived concept on technology integration and technology-integrated teaching practices, and their knowledge seeking area would be worth investigating. The teachers' enacted technology-based teaching practices have not been delved into in the realm of this research. However, during the interview, I often had impressions that the concept of technology integration is perceived differently among teachers in District A and District B. Hughes (2005) proposed the Replacement, Amplification, and Transformation (RAT) framework to represent ways technology is implemented. In a replacement situation, technology is implemented as a replacement for existing non-technological material (e.g., using iPad for note-taking instead of paper-based notebook) whereas when technology is used to amplify, it enhances efficiency of tasks (e.g., using Google Form to gather student answer

responses rather than collecting assignment papers). Technology can be also used in a transformative way when it changes the ways for student learning (e.g., watching marine life via a live camera installed underwater and having students research on it). Applying the RAT framework proposed by Hughes (2005), it seems that District A teachers' technology integration were more inclined toward amplified and transformative use of technology whereas District B teachers seemed to use technology at the basic level where technology use in classroom is a mere replacement of existing tools, not having a big impact on enhancing student learning. I recommend researchers use a model, such as RAT, to investigate relationship between teachers' knowledge-needed area, and their technology integration concept and actual teaching practices.

Second, a longitudinal study on teacher information seeking areas with regard to district support for professional learning opportunities will also provide insight on how to support teachers. The following questions could be pursued: What is the relationship between various support mechanisms and teachers' online information seeking over time? What are the main causes for the relationship? Those questions will help better understand support-needed areas in relation to given opportunities to teachers.

Limitations

Participants and sample size. There was a large difference in the number teachers participating in the study both for quantitative and qualitative data, with District A having more participating teachers. As data collection in District B started slightly later in the academic year, a smaller number of teachers may have responded to the survey and

agreed to interview due to busy end of year schedules. Thus, the smaller representation of District B teachers than District A teachers might have impeded generalization of the findings. Moreover, the survey had no high school teacher participants from District B responding to the survey. Given that the District B had a 1:1 iPad initiative in the high schools, participation of District B high school teachers might have provided a more complete picture on online information-seeking behavior of teachers in District B.

Selection bias. Another limitation of the study is selection bias that might have been caused by using an online survey tool. The survey data collection was solely performed through the online survey tool. This might have influenced teachers' willingness to complete the survey as it is likely that technology-prone teachers might respond more than non-technology-prone teachers.

Indirect survey distribution. The researcher was not able to access individual teachers' email accounts. The link to the online survey was emailed by the principals of each school to teachers, hence teachers were unable to save the survey and restart from where they left off, a feature that is possible when a unique link to their survey is generated in accordance with an email address. This condition might have impacted the number of survey respondents of the survey. It is possible that teachers opened the survey from one device (e.g., their iPads in school) but got disturbed by something and then tried to answer the survey at later time from another device (e.g., personal computer at home). Direct access to teachers' email could help resolve this issue but such personal information is often protected by school districts.

Appendices

Appendix A: Online Information-Seeking Survey

Consent to Participate in Internet Research

Identification of Investigator and Purpose of Study
You are invited to participate in a research study, entitled "Information-Seeking Behaviors of Teachers for Technology Integration." The study is being conducted by Yujung Ko from Curriculum and Instruction Dept. of The University of Texas at Austin, 585-386-9196, yujung.ko@utexas.edu. The purpose of this research study is to examine teachers' online information-seeking to find information about technology-based instruction. Your participation in the study will contribute to a better understanding of how teachers search for online information and what online sites they use. You are free to contact the investigator at the above address and phone number to discuss the study. If you agree to participate:

- You will take a 15 minute, online survey.
- You may volunteer to participate in a 60-minute interview scheduled at your convenience.

Risks/Benefits/Confidentiality of Data
There are no known risks. There will be no costs for participating, nor will you benefit directly from participating. If you share your name and email address (for an interview), it will be confidential. Only I will have access to the data. Any identifying information will be stripped from the final dataset.

Participation or Withdrawal
Your participation in this study is voluntary. You may decline to answer any question, and you have the right to withdraw from participation at any time. Withdrawal will not affect your relationship with The University of Texas in anyway. If you do not want to participate either simply stop participating or close the browser window.

Contacts
If you have any questions about the study or need to update your email address, contact the researcher Yujung Ko at 585-386-9196 or send an email to yujung.ko@utexas.edu. This study has been reviewed by The University of Texas at Austin Institutional Review Board and the study number is [2017-03-0007].

Questions about your rights as a research participant
If you have questions about your rights or are dissatisfied at any time with any part of this study, you can contact, anonymously if you wish, the Institutional Review Board by phone at (512) 471-8871 or email at orsc@uts.cc.utexas.edu.

If you agree to participate, click on next button. Thank you.

Introduction

Thank you so much for deciding to participate!

This survey will help me understand what information you search for and how you have used online resources to seek the information **about integrating technology** in your classroom.

Technology integration means: teachers or students using digital technologies for teaching and/or learning subject area content (e.g., math, science, PE, art, etc.)

I will ask questions about:

- what online information about technology integration you seek
- what online sites/sources you use to get this information
- how valuable you think the online sites/sources are, and
- your and your students' technology use.

The survey should take about 10-15 minutes to complete. Please read instructions carefully.

In the next three sections of the survey, you will be asked about three types of information you might seek online.

1. **Technical Know-How**: How a technical object, such as a computing device, software, or printer, technically works.
2. **Subject Area/Content Technologies**: Technologies (e.g., tools or websites) that communicate, teach, or represent subject area content for instructional or learning purposes.
3. **General Instructional Technologies**: Digital tools or ways of using tools to support general instruction, such as assessment, lectures, student presentations.

Each type will be explained at the beginning of the sections.

TK - Information Content

The next series of questions is about: **TECHNICAL KNOW-HOW.**

Technical Know-How is information about a technical object, like a computing device, software, or printer, and/or how these objects technically work.

Examples of online searches for technical know-how include:

- searching for how to connect your projector
- searching for 3D printers
- searching for how to make a short movie
- searching for info on what virtual reality is

For the following questions,

1. Think about your online search patterns between August 2016 - today.
2. Indicate your approximate frequency of searching for information about technical know-how.

Indicate your approximate frequency of searching for information about TECHNICAL KNOW-HOW.

	Never	Once or twice in a *month*	Once or twice in a *week*	Three to four times in a *week*	Daily or more often
I search for information online about how to use technology hardware, software, and/or apps (e.g., creating Prezi presentation).	○	○	○	○	○
I search for information online about how to troubleshoot hardware, software, and/or apps (e.g., fixing Internet connection problems).	○	○	○	○	○
I search for information online about new or emerging hardware, software, and/or apps (e.g., GoPro, 3D printers, virtual reality, Apple watch).	○	○	○	○	○

TK - Information Sources

For the following questions,

1. Think about your online search patterns between August 2016 - today.
2. Indicate your approximate frequency of using the following online information **sources** when you search for information about technical know-how. (If you do not recognize a source, you have probably never used it.)

Definition: Technical Know-How is information about a technical object, like a computing device, software, or printer, and/or how these objects technically work.

***Examples** of online searches for technical know-how include:*

- *searching for how to connect your projector*
- *searching for 3D printers*
- *searching for how to make a short movie*
- *searching for info on what virtual reality is*

Indicate your approximate frequency of using the following online information SOURCES when you search for information about TECHNICAL KNOW-HOW.

	Never	Once or twice in a *month*	Once or twice in a *week*	Three to four times in a *week*	Daily or more often
Web search engine (e.g., Google, Bing)	○	○	○	○	○
Twitter	○	○	○	○	○
Facebook	○	○	○	○	○
Pinterest	○	○	○	○	○
Padlet	○	○	○	○	○
Blogs	○	○	○	○	○

YouTube	○	○	○	○	○
TeacherTube	○	○	○	○	○
Wikipedia	○	○	○	○	○
Google Scholar	○	○	○	○	○
Quora	○	○	○	○	○
Online community (e.g., Edmodo, Ning)	○	○	○	○	○
Online library databases (e.g., EBSCO)	○	○	○	○	○
Government/state website (e.g., TEA, USDOE)	○	○	○	○	○
Research institution/organization website (e.g., New Media Consortium, Pew Research Center)	○	○	○	○	○
Professional organization website (e.g., NCTE, AAAS, TCEA, NCTM)	○	○	○	○	○
Newspaper website (e.g., New York Times, Education Week)	○	○	○	○	○

Please describe any other online sources you use if it is not listed above (up to 3). Be sure to indicate frequency for each information search.

	Once or twice in a *month*	Once or twice in a *week*	Three to four times in a *week*	Daily or more often

Other 1	○	○	○	○
Other 2	○	○	○	○
Other 3	○	○	○	○

TK – Value Rating for Online Information Sources

For the following questions:

1. For each online information source you have used to search for information about technical know-how, please determine its **value** in providing you applicable technical know-how information.

Definition: Technical Know-How is information about a technical object, like a computing device, software, printers, and/or how these objects technically work.

***Examples** of online searches for technical know-how include:*

- *searching for how to connect your projector*
- *searching for 3D printers*
- *searching for how to make a short movie*
- *searching for info on what virtual reality is*

For each online information source you have used to search for information about technical know-how, please determine its VALUE in providing you applicable TECHNICAL KNOW-HOW information.

	Not valuable	Somewhat valuable	Valuable	Very valuable	Extremely valuable
Web search engine (e.g., Google, Bing)	○	○	○	○	○
Twitter	○	○	○	○	○
Facebook	○	○	○	○	○
Pinterest	○	○	○	○	○
Padlet	○	○	○	○	○
Blogs	○	○	○	○	○

YouTube	○	○	○	○	○
TeacherTube	○	○	○	○	○
Wikipedia	○	○	○	○	○
Google Scholar	○	○	○	○	○
Quora	○	○	○	○	○
Online community (e.g., Edmodo, Ning)	○	○	○	○	○
Online library databases (e.g., EBSCO)	○	○	○	○	○
Government/state website (e.g., TEA, USDOE)	○	○	○	○	○
Research institution/organization website (e.g., New Media Consortium, Pew Research Center)	○	○	○	○	○
Professional organization website (e.g., NCTE, AAAS, TCEA, NCTM)	○	○	○	○	○
Newspaper website (e.g., New York Times, Education Week)	○	○	○	○	○
Other 1.	○	○	○	○	○
Other 2.	○	○	○	○	○
Other 3.	○	○	○	○	○

TCK - Information Content

The next series of questions is about: **SUBJECT AREA/CONTENT TECHNOLOGIES.**

Subject Area/Content Technologies are technologies (e.g., tools or websites) that digitally communicate, teach, or represent subject area content for instructional or learning purposes.

Examples of online searches for subject area/content technologies that qualify for this category include:

- looking for primary source apps for history class
- looking for a rollercoaster simulation for physics class
- looking for a live camera website of wild animals for biology class
- finding virtual manipulatives for math class
- searching for music composition app for music
- searching for Google Earth lessons for geography/social studies
- examining digital storytelling apps for ELA
- looking for audio/video recordings of Hamlet performances for English class

Non-examples of online search for subject area/content technologies that are disqualified for this category include:

- looking for a writing prompt handout that will be printed and distributed on paper to students
- looking for statistics formula to solve a problem
- researching information about the role of United Nations during WWII to help build a class lecture

For the following questions,

1. Think about your online search patterns between August 2016 - today.
2. Indicate your approximate frequency of searching for information about subject area/content technologies.

Indicate your approximate frequency of searching for information about SUBJECT AREA/CONTENT TECHNOLOGIES.

	Never	Once or twice in a *month*	Once or twice in a *week*	Three to four times in a *week*	Daily or more often

I search for information online to identify various subject-specific technologies applicable for my subject area(s).	○	○	○	○	○
I search for information online about how to use subject-specific technologies in my subject area(s).	○	○	○	○	○
I search for information online about ways subject-specific technologies might change my instruction or my students' learning.	○	○	○	○	○

TPK - Information Sources

For the following questions,

1. Think about your online search patterns between August 2016 - today.
2. Indicate your approximate frequency of using the following online information **sources** when you search for information about subject area/content technologies. (If you do not recognize a source, you have probably never used it.)

Definition: Subject Area/Content Technologies are technologies (e.g., tools or websites) that digitally communicate, teach, or represent subject area content for instructional or learning purposes.

***Examples** of online searches for subject area/content technologies that qualify for this category include:*

- *looking for primary source apps for history class*
- *looking for a rollercoaster simulation for physics class*
- *looking for a live camera website of wild animals for biology class*
- *finding virtual manipulatives for math class*
- *searching for music composition app for music*
- *searching for Google Earth lessons for geography/social studies*
- *examining digital storytelling apps for ELA*
- *looking for audio/video recordings of Hamlet performances for English class*

***Non-examples** of online search for subject area/content technologies that are disqualified for this category include:*

- *looking for a writing prompt handout that will be printed and distributed on paper to students*
- *looking for statistics formula to solve a problem*
- *researching information about the role of United Nations during WWII to help build a class lecture*

Indicate your approximate frequency of using the following online information SOURCES when you search for information about SUBJECT AREA/CONTENT TECHNOLOGIES.

	Never	Once or twice in a *month*	Once or twice in a *week*	Three to four times in a *week*	Daily or more often
Web search engine (e.g., Google, Bing)	○	○	○	○	○
Twitter	○	○	○	○	○
Facebook	○	○	○	○	○
Pinterest	○	○	○	○	○
Padlet	○	○	○	○	○
Blogs	○	○	○	○	○
YouTube	○	○	○	○	○
TeacherTube	○	○	○	○	○
Wikipedia	○	○	○	○	○
Google Scholar	○	○	○	○	○
Quora	○	○	○	○	○
Online community (e.g., Edmodo, Ning)	○	○	○	○	○

Online library databases (e.g., EBSCO)	○	○	○	○	○
Government/state website (e.g., TEA, USDOE)	○	○	○	○	○
Research institution/organization website (e.g., New Media Consortium, Pew Research Center)	○	○	○	○	○
Professional organization website (e.g., NCTE, AAAS, TCEA, NCTM)	○	○	○	○	○
Newspaper website (e.g., New York Times, Education Week)	○	○	○	○	○

Please describe any other online sources you use if it is not listed above (up to 3). Be sure to indicate frequency for each information search.

	Once or twice in a *month*	Once or twice in a *week*	Three to four times in a *week*	Daily or more often
Other 1	○	○	○	○
Other 2	○	○	○	○
Other 3	○	○	○	○

TCK – Value Rating for Online Information Sources

For the following questions:

1. For each online information source you have used to search for information about subject area/content technologies, please determine its **value** in providing you applicable subject area/content technologies information.

Definition: Subject Area/Content Technologies are technologies (e.g., tools or websites) that digitally communicate, teach, or represent subject area content for instructional or learning purposes.

***Examples** of online searches for subject area/content technologies that qualify for this category include:*

- *looking for primary source apps for history class*
- *looking for a rollercoaster simulation for physics class*
- *looking for a live camera website of wild animals for biology class*
- *finding virtual manipulatives for math class*
- *searching for music composition app for music*
- *searching for Google Earth lessons for geography/social studies*
- *examining digital storytelling apps for ELA*
- *looking for audio/video recordings of Hamlet performances for English class*

***Non-examples** of online search for subject area/content technologies that are disqualified for this category include:*

- *looking for a writing prompt handout that will be printed and distributed on paper to students*
- *looking for statistics formula to solve a problem*
- *researching information about the role of United Nations during WWII to help build a class lecture*

For each online information source you have used to search for information about subject area/content technologies, please determine its VALUE in providing you applicable SUBJECT AREA/CONTENT TECHNOLOGIES information.

	Not valuable	Somewhat valuable	Valuable	Very valuable	Extremely valuable
Web search engine (e.g., Google, Bing)	○	○	○	○	○
Twitter	○	○	○	○	○
Facebook	○	○	○	○	○
Pinterest	○	○	○	○	○
Padlet	○	○	○	○	○
Blogs	○	○	○	○	○
YouTube	○	○	○	○	○
TeacherTube	○	○	○	○	○
Wikipedia	○	○	○	○	○
Google Scholar	○	○	○	○	○
Quora	○	○	○	○	○
Online community (e.g., Edmodo, Ning)	○	○	○	○	○
Online library databases (e.g.,	○	○	○	○	○

EBSCO)					
Government/state website (e.g., TEA, USDOE)	○	○	○	○	○
Research institution/organization website (e.g., New Media Consortium, Pew Research Center)	○	○	○	○	○
Professional organization website (e.g., NCTE, AAAS, TCEA, NCTM)	○	○	○	○	○
Newspaper website (e.g., New York Times, Education Week)	○	○	○	○	○
Other 1.	○	○	○	○	○
Other 2.	○	○	○	○	○
Other 3.	○	○	○	○	○

TPK - Information Content

The next series of questions is about: **GENERAL INSTRUCTIONAL TECHNOLOGIES**.

General Instructional Technologies include digital tools or ways of using tools to support general instruction and learning, such as for assessment, lectures, and presentations.

Examples of online searches for general instructional technologies that qualify for this category include:

- identifying technologies you or your students can use to present information in class
- looking for technological tools to help students map out (organize) concepts or information
- finding technologies to assist with student collaboration
- looking for ways to guide students to research information using various online resources
- searching for ways to use technologies to help with grading and assessment

For the following questions,

1. Think about your online search patterns between August 2016 - today.
2. Indicate your approximate frequency of searching for information about general instructional technologies.

Indicate your approximate frequency of searching for information about GENERAL INSTRUCTIONAL TECHNOLOGIES.

	Never	Once or twice in a *month*	Once or twice in a *week*	Three to four times in a *week*	Daily or more often
I search for information online about how to motivate students with technology.	○	○	○	○	○
I search for information online about how to	○	○	○	○	○

differentiate instruction with technology hardware, software, and/or apps.					
I search for information online about how to foster collaborative learning with technology.	○	○	○	○	○
I search for information online about how to teach students to be accountable for using technology equipment.	○	○	○	○	○
I search for information online about alternatives in the event of technological failures/challenges.	○	○	○	○	○
I search for information online about how to explain or teach a technological procedure to students.	○	○	○	○	○
I search for information online about standards for students' technological literacy (e.g., ISTE standards for students).	○	○	○	○	○
I search for information online about technologies for lesson planning preparation.	○	○	○	○	○
I search for information online about strategies for using technology to assess student work.	○	○	○	○	○
I search for information online about technological software and hardware available at my school site.	○	○	○	○	○

I search for information online about how to manage a classroom when students are using technology.	○	○	○	○	○
I search for information online about reviews/evaluations of technological resources (e.g., hardware, software) for instruction.	○	○	○	○	○

TPK - Information Sources

For the following questions,

1. Think about your online search patterns between August 2016 - today.
2. Indicate your approximate frequency of using the following online information **sources** when you search for information about general instructional technologies. (If you do not recognize a source, you have probably never used it.)

Definition: General Instructional Technologies include digital tools or ways of using tools to support general instruction, such as assessment, lectures, student presentations.

***Examples** of online searches for general instructional technologies that qualify for this category include:*

- *identifying technologies you or your students can use to present information in class*
- *looking for technological tools to help students map out (organize) concepts or information*
- *finding technologies to assist with student collaboration*
- *looking for ways to guide students to research information using various online resources*
- *searching for ways to use technologies to help with grading and assessment*

Indicate your approximate frequency of using the following online information SOURCES when you search for information about GENERAL INSTRUCTIONAL TECHNOLOGIES.

	Never	Once or twice in a *month*	Once or twice in a *week*	Three to four times in a *week*	Daily or more often
Web search engine (e.g., Google, Bing)	○	○	○	○	○
Twitter	○	○	○	○	○
Facebook	○	○	○	○	○

Pinterest	○	○	○	○	○
Padlet	○	○	○	○	○
Blogs	○	○	○	○	○
YouTube	○	○	○	○	○
TeacherTube	○	○	○	○	○
Wikipedia	○	○	○	○	○
Google Scholar	○	○	○	○	○
Quora	○	○	○	○	○
Online community (e.g., Edmodo, Ning)	○	○	○	○	○
Online library databases (e.g., EBSCO)	○	○	○	○	○
Government/state website (e.g., TEA, USDOE)	○	○	○	○	○
Research institution/organization website (e.g., New Media Consortium, Pew Research Center)	○	○	○	○	○
Professional organization website (e.g., NCTE, AAAS, TCEA, NCTM)	○	○	○	○	○
Newspaper website (e.g., New York Times, Education Week)	○	○	○	○	○

Please describe any other online sources you use if it is not listed above (up to 3). Be sure to indicate frequency for each information search.

	Once or twice in a *month*	Once or twice in a *week*	Three to four times in a *week*	Daily or more often
Other 1	○	○	○	○
Other 2	○	○	○	○
Other 3	○	○	○	○

TPK – Value Rating for Online Information Sources

For the following questions,

1. For each online information source you have used to search for information about general instructional technologies, please determine its **value** in providing you applicable general instructional technologies information.

Definition: General Instructional Technologies include digital tools or ways of using tools to support general instruction, such as assessment, lectures, student presentations.

***Examples** of online searches for general instructional technologies that qualify for this category include:*

- *identifying technologies you or your students can use to present information in class*
- *looking for technological tools to help students map out (organize) concepts or information*
- *finding technologies to assist with student collaboration*
- *looking for ways to guide students to research information using various online resources*
- *searching for ways to use technologies to help with grading and assessment*

For each online information source you have used to search for information about general instructional technologies, please determine its VALUE in providing you applicable GENERAL INSTRUCTIONAL TECHNOLOGIES information.

	Not valuable	Somewhat valuable	Valuable	Very valuable	Extremely valuable
Web search engine (e.g., Google, Bing)	○	○	○	○	○
Twitter	○	○	○	○	○
Facebook	○	○	○	○	○
Pinterest	○	○	○	○	○

Padlet	○	○	○	○	○
Blogs	○	○	○	○	○
YouTube	○	○	○	○	○
TeacherTube	○	○	○	○	○
Wikipedia	○	○	○	○	○
Google Scholar	○	○	○	○	○
Quora	○	○	○	○	○
Online community (e.g., Edmodo, Ning)	○	○	○	○	○
Online library databases (e.g., EBSCO)	○	○	○	○	○
Government/state website (e.g., TEA, USDOE)	○	○	○	○	○
Research institution/organization website (e.g., New Media Consortium, Pew Research Center)	○	○	○	○	○
Professional organization website (e.g., NCTE, AAAS, TCEA, NCTM)	○	○	○	○	○
Newspaper website (e.g., New York Times, Education Week)	○	○	○	○	○

Other 1.	○	○	○	○	○
Other 2.	○	○	○	○	○
Other 3.	○	○	○	○	○

Technology Usage of Teacher and Students

In the next two sections of the survey, you will be asked about two types of technology use--by you, the teacher, and by your students.

For the sections, indicate how often **you or your students** use technology devices in your classroom **for instruction or learning**.

TOPIC: **TEACHER TECHNOLOGY USE**

For the following questions,

1. Think about your technology use for instruction between August 2016 - today.
2. For each technology device listed, indicate how often **you, the teacher**, use it in your classroom **for instruction** (in your hands)?

	Not available in my school/ classroom	Available but never use	Once or twice in a *month*	Once or twice in a *week*	Three to four times in a *week*	Daily or more often
Tablet (e.g., iPad, Galaxy Tab)	○	○	○	○	○	○
Laptop computer (e.g., MacBook, Chromebook)	○	○	○	○	○	○
Desktop computer	○	○	○	○	○	○
Classroom Response System (e.g., Clicker, Kahoot)	○	○	○	○	○	○
Interactive White Board (e.g., SMART Board, Activeboard)	○	○	○	○	○	○
Digital projector/Apple TV	○	○	○	○	○	○

Digital camera/Digital video camera	○	○	○	○	○	○
Music player (e.g., MP3 player)	○	○	○	○	○	○
Document camera (e.g., ELMO)	○	○	○	○	○	○

Please describe any other technology devices **you** use **for instruction** if it is not listed above (up to 3). Be sure to indicate frequency for each device use.

	Once or twice in a *month*	Once or twice in a *week*	Three to four times in a *week*	Daily or more often
Other 1	○	○	○	○
Other 2	○	○	○	○
Other 3	○	○	○	○

TOPIC: **STUDENTS TECHNOLOGY USE**

For the following questions,

1. Think about your students' technology use for learning between August 2016 - today.
2. For each technology device listed, indicate how often the **students** in your classroom use it **for learning** (in your STUDENTS' hands)?

	Not available in my school/classroom	Available but never use	Once or twice in a *month*	Once or twice in a *week*	Three to four times in a *week*	Daily or more often
Tablet (e.g., iPad, Galaxy Tab)	○	○	○	○	○	○
Laptop computer (e.g., MacBook, Chromebook)	○	○	○	○	○	○
Desktop computer	○	○	○	○	○	○
Classroom Response System (e.g., Clicker, Kahoot)	○	○	○	○	○	○
Interactive White Board (e.g., SMART Board, Activeboard)	○	○	○	○	○	○
Digital projector/Apple TV	○	○	○	○	○	○
Digital camera/Digital video camera	○	○	○	○	○	○
Music player (e.g., MP3 player)	○	○	○	○	○	○

Document camera (e.g., ELMO)	○	○	○	○	○	○

Please describe any other technology devices your **students** use **for learning** if it is not listed above (up to 3). Be sure to indicate frequency for each device use.

	Once or twice in a *month*	Once or twice in a *week*	Three to four times in a *week*	Daily or more often
Other 1	○	○	○	○
Other 2	○	○	○	○
Other 3	○	○	○	○

Professional Development

Thinking from last summer (June 2016) through today, how many **HOURS** did you spend in professional development (PD) activities **for learning about technology integration** (e.g., workshops, meetings, guest lectures, conferences, courses, coordinated workgroups)?

Please enter a number. *If it is a multi-day PD, enter a number for total hours. For example, a 2-day long PD with 8 hours a day will be 16 hours*.

_____

What percentage of the XX hours for technology integration professional development you indicated was provided by your school and/or district?

	0 10 20 30 40 50 60 70 80 90 100
(Drag a bar to indicate the percentage)	

Demographic Information

My final questions help me understand who you are.

1. What year were you born?

_____

2. What is your gender?

- ○ Male
- ○ Female

3. How many years have you taught in K-12 classrooms (including this year)? (Please enter a number. *If none, enter 0*)

- ○ Elementary school _____
- ○ Middle school _____
- ○ High school _____

4. Please select the school where you teach now.

▼

5. What grade(s) are you teaching now? (Check all that apply)

- [ ] Pre-K
- [ ] Kindergarten
- [ ] 1st Grade
- [ ] 2nd Grade
- [ ] 3rd Grade
- [ ] 4th Grade
- [ ] 5th Grade
- [ ] 6th Grade
- [ ] 7th Grade
- [ ] 8th Grade
- [ ] 9th Grade
- [ ] 10th Grade
- [ ] 11th Grade
- [ ] 12th Grade

6. What subject(s) are you teaching? (Check all that apply)

- [ ] Art
- [ ] English/English Language Arts

- [ ] English as a Second Language
- [ ] Foreign Language/World Languages
- [ ] Mathematics
- [ ] Music
- [ ] Physical Education
- [ ] Science
- [ ] Social Studies
- [ ] Special Education
- [ ] Career & Technical Education
- [ ] All subjects
- [ ] Other (*please specify*)

_____

7. Through which pathway were you certified as a teacher?

- ○ Preservice teacher preparation program
- ○ Post-baccalaureate program
- ○ Alternative certification program
- ○ Emergency certification
- ○ No certification
- ○ Other (*please specify*)

_____

8. Your highest level of education?

- ○ Bachelor's
- ○ Master's
- ○ Doctorate (Ed.D. or Ph.D.)
- ○ Other (*please specify*)

_____

9. What is your ethnicity?

- ○ White/Caucasian
- ○ Black or African American
- ○ Hispanic
- ○ Asian
- ○ American Indian or Alaska Native
- ○ Native Hawaiian or Pacific Islander
- ○ Other (*please specify*)

_____

10. Would you be willing to participate in an interview with me about your online information-seeking experiences for technology integration in near future, scheduled at your convenience?
The interview will be performed individually via whichever means you prefer to (e.g., face-to-face, phone call, Skype, or Google Hangouts).

- ○ Yes
- ○ No

11. Please provide your name so I can contact you for an interview (your name will be confidential).

_____

12. Please provide your phone number & email so I can contact you for an interview (your phone number and email will be confidential).

- ○ Phone Number _____
- ○ Email _____

Appendix B: Semi-structured Interview Protocol

1. Tell me about what technology integration for teaching and learning means to you.
2. Tell me about your school's expectations for technology integration in classrooms.
3. Tell me about your most recent online information search for technology-integrated teaching and learning.
    a. What made you do the search?
    b. Describe how you engaged in the online information search. What kinds of information were you seeking out? Through what sources?
    c. What did you learn from the online information search?
4. Since you started online information search for technology integration, was there a change in your online information-seeking practices in terms of content and sources of information?
    a. What remains the same?
    b. What is different?
5. Your survey indicated of the online sources, the most valuable was [INSERT SOURCE BASED ON SURVEY RESULT]?
    a. Tell me about that.

6. You indicated you search most often for [INSERT SOURCE BASED ON SURVEY RESULT]. Do you think that represents your most needed information for using technology for teaching and learning?
    a. What would be your strategies/resources to support the information need?
    b. How do you want your school and/or district to support you for the information need?

Appendix C: Research Matrix

Research Question	Data Sources	Specific data to answer this question	Analysis Required	What will this allow me to say?
1. In terms of TK, TCK, and TPK, what online information do teachers seek about technology integration?	Survey	Content of Online Information-Seeking	Descriptive statistics & T-test (SPSS)	*The most searched online content for teachers in Districts A and B was TCK.* *High school teachers searched more for online information about TK.*
2. What online sources do teachers use for seeking information on technology integration?	Survey	Sources of Online Information-Seeking	Descriptive statistics (SPSS)	*Middle school teachers used YouTube the most for seeking online information about technology-supported instruction.*
3. How do teachers value the online information sources they use?	Survey	Value Ratings for Online Sources	Descriptive statistics (SPSS)	*Teachers valued YouTube highly in searching for information about technological know-how.* *The lowest rated online sources were Google Scholar for teachers in Districts A and B.*

Research Question	Data Sources	Specific data to answer this question	Analysis Required	What will this allow me to say?
4. What are the similarities and differences of teachers' online information-seeking behaviors about technology integration among school districts, school levels, and subject areas?	Survey	Content and Sources of Online Information-Seeking, Value Ratings for Online Sources	Descriptive statistics (SPSS)	*Overall, the most searched knowledge area for District A teachers was TCK while it was TPK for District B teachers.* *There is a statistically significant difference between TK-related online information seeking for three teacher groups in elementary, middle, and high schools ($p < .05$).* *One of the top five resources for science teachers was YouTube, but it was not listed in the top five for English teachers.*
	Interview	Interview questions 3 through 5	Constant comparative method	*Teachers in District A had in common in that they all started to search online information for effective technology integration due to district-wide 1:1 iPad initiative with insufficient PD offerings.*

Appendix D: Executive Summary for District A

Executive Summary – District A

This executive summary presents: (a) results from data collected from teachers at schools in District A in April - May 2017 and (b) suggested next step based on data results. The goal of the study was to understand K-12 teachers' online information-seeking behaviors regarding technology-integrated teaching and learning. A web-based survey was administered to school teachers via an email invitation and interviews with teachers followed. 143 teachers completed the surveys from elementary, middle, and high schools and, from them, 11 participated in follow-up interviews. The survey asked about content and sources of online information teachers sought for technology integration and their perceived value of these online sources. The information content was categorized into three knowledge areas, which are about technological know-how (i.e., Technological Knowledge, TK), subject area/content technologies (i.e., Technological Content Knowledge, TCK), and general instructional technologies (i.e., Technological Pedagogical Knowledge, TPK).

Information Content

Among the three knowledge areas, District A teachers reported searching for (in order of frequency):

1. TCK (e.g., how to use subject-specific technologies in my subject area);
2. TK (e.g., how to use technology hardware, software, and/or apps); and
3. TPK (e.g., how to motivate students through technology).

The pattern of TCK being most searched and TK and TPK being the second and the third was shown to be the same across school levels. For TK and TCK, elementary school teachers reported being the most active seekers, and middle school and high school teachers were found to be the second and the third frequent seekers. However, for TPK, high school teachers' information search frequency exceeded that of middle school teachers.

Information Sources and Value Ratings

The top five online information resources teachers reported using for seeking each type of information included (in order of use frequency):

- TK: 1) web search engine, 2) YouTube, 3) newspaper website (e.g., New York Times, Education Week), 4) Facebook, and 5) Wikipedia
- TCK: 1) web search engine, 2) YouTube, 3) Pinterest, 4) newspaper website, and 5) Wikipedia
- TPK: 1) web search engine, 2) YouTube, 3) Pinterest, 4) newspaper website, and 5) government/state website (e.g., TEA, USDOE)

Interview results revealed that different sources served different purposes. For example, teachers searched information on YouTube for step-by-step guides for technological know-how and Facebook for teacher learning through communities of teachers from the same subject area. Overall, teachers indicated higher value ratings for online resources they used more frequently.

Suggested Next Step

Based on data results, I would like to suggest the following recommendations to help improve technology integration professional development for your teachers:

1) Professional Development
    a) Topic: Use of technologies to enhance student content learning
    b) Topic: How to become a connected educator (focus on tips and strategies for online information searching and on how to use social media for teachers' knowledge development)
    c) More information about each PD session to be shared in advance
2) Encouraging idea sharing for technology integration during PLC
3) Continued excellence in school technology leadership

Appendix E: Executive Summary for District B

Executive Summary – District B

This executive summary presents: (a) results from data collected from teachers at schools in District B in April - May 2017 and (b) suggested next step based on data results. The goal of the study was to understand K-12 teachers' online information-seeking behaviors regarding technology-integrated teaching and learning. A web-based survey was administered to school teachers via an email invitation and interviews with teachers followed. 32 teachers completed the surveys from elementary and middle schools (no high schools) and, from them, three participated in follow-up interviews. The survey asked about content and sources of online information teachers sought for technology integration and their perceived value of these online sources. The information content was categorized into three knowledge areas, which are about technological know-how (i.e., Technological Knowledge, TK), subject area/content technologies (i.e., Technological Content Knowledge, TCK), and general instructional technologies (i.e., Technological Pedagogical Knowledge, TPK). Given the small number of respondents, the following data should not be interpreted as a representative sample of all teachers in District B, and thus, conclusions from this data should be interpreted cautiously.

Information Content

Among the three knowledge areas, District B teachers reported searching for (in order of frequency):

1. TCK (e.g., how to use subject-specific technologies in my subject area);
2. TPK (e.g., how to motivate students through technology); and
3. TK (e.g., how to use technology hardware, software, and/or apps).

Middle school teachers reported seeking TK slightly more than TPK.

Information Sources and Value Ratings

The top five online information resources teachers reported using for seeking each type of information included (in order of use frequency):

- TK: 1) web search engine, 2) YouTube, 3) Pinterest, 4) Facebook, and 5) Wikipedia
- TCK: 1) web search engine, 2) YouTube, 3) Pinterest, 4) newspaper website (e.g., New York Times, Education Week), and 5) Wikipedia
- TPK: 1) web search engine, 2) YouTube, 3) Pinterest, 4) Wikipedia, and 5) government/state website (e.g., TEA, USDOE)

Overall, teachers indicated higher value ratings for online resources they used more frequently.

Suggested Next Step

Based on data results, I would like to suggest the following recommendations to help improve technology integration professional development for your teachers:

1) Professional Development
    a) Topic: Use of technologies to enhance student content learning

   b) Topic: How to become a connected educator (focus on tips and strategies for online information searching and on how to use social media for teachers' knowledge development)
   c) More offerings that vary in learning time (e.g., 30-minute, 2-hour, and a day-long sessions) and topics throughout school year
2) Creating an "Information Hub" that contains FAQs regarding technology integration, step-by-step guides on technological information, useful resources and tools for technology-supported instruction, recordings and materials of past PD sessions, etc.
3) Extended individualized support for teachers, especially about teaching and learning with technology
4) Promoting PLCs and encouraging idea sharing for technology integration during the PLC

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